59401A

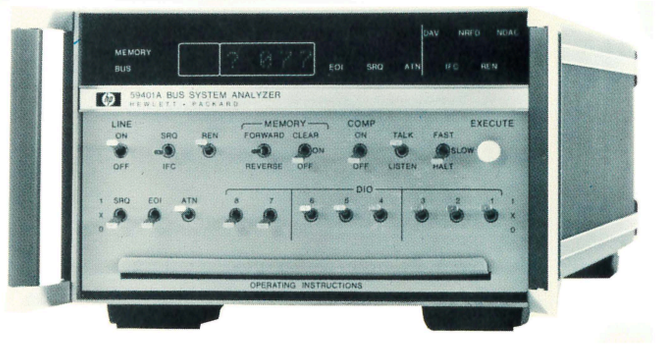
BUS SYSTEM ANALYZER

59401A

59401-90002
Printed in U.S.A.

OPERATING AND SERVICE MANUAL

BUS SYSTEM ANALYZER
59401A



HEWLETT PACKARD

-hp- 59401A

MODEL 59401A BUS SYSTEM ANALYZER
USER COMMENT SHEET

TO THE USER: We want our manuals and instruments to suit your needs. You can help us achieve this by entering your comments, ideas and suggestions below. Then fold, staple and drop this sheet in the mail. It will receive our prompt attention. Some of the items which you may wish to comment on are: graphics, schematics/flowcharts, tables, general manual layout, parts, procedures, theory, troubleshooting, applications, specifications, as well as the instrument itself. Feel free to point out any errors or confusing items in the text or any other portions of the manual.

FROM _____ JOB TITLE _____

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COMMENTS: _____

REPLY REQUESTED? YES ☐ NO ☐

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FROM _____

_____

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First Class
Permit No. 37
Loveland, Colorado

LOVELAND INSTRUMENT DIVISION
CUSTOMER SERVICE TEAM,DEPT. 4160
P.O. Box 301
LOVELAND, COLORADO 80537
U.S.A.

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HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 59401A

BUS SYSTEM ANALYZER

Applies to Serials Prefixed 1914A

IMPORTANT NOTICE

This manual does not normally require change sheets. All backdating and major change information is integrated into the manual by means of revised pages. However, in cases where only minor changes are requried, a change sheet may be supplied. A record of all revisions and changes is located behind the title page. Any changed information is indicated by a vertical bar in the margin and/or a numbered delta (Δ_1). The Δ_1 refers to a corresponding footnote which explains the change and tells which serial numbers the change applies to.

WARNING

To help prevent potential fire or shock hazard, do not expose this instrument to rain or moisture.

Manual Part No. 59401-90002

Microfiche Part No. 59401-90052

Revision B

P.O. Box 301, Loveland, Colorado 80537 U.S.A.

Printed: February 1979

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

Record of Revisions.

Model 59401A Bus System Analyzer

Manual Part Number 59401-90002

Hewlett-Packard Company issues revisions periodically to keep manuals up-to-date. A manual becomes "Revision A" the first time it is reprinted with revised material included. Thus, each revision is associated with a particular date. Each revised page bears the notation "Rev A" at the bottom of the page; It also has a vertical bar in the margin adjacent to the revised information. The second revision of the manual is "Rev. B", and so on.

The Record of Revisions pages provide an index to all of the revised material in the manual. They apply only to manuals with the part number shown at the top of this page. Keep this record with your manual for future reference.

	Pages	Title	Nature of Change
Rev. A	Title Page		Revision Level and Date
5-13-77	iii	Table of Contents	Page Numbers
	3-1, 4-3	Note	Update Wording (09-14792)
	3-5, 3-8		Correct Errors
	4-1	Table 4-1	Update
	4-2	Table 4-2	Update Test Equipment
	5-1		Correct Wording
	6-12	Parts List MP23	Update Part Number
	7-27		Correct Error
	7-45		Enhance Description
	Appendix A	Introduction	Add
	B1, B2	Appendix B	Add Letter of Appendix
	C1 - C3	Appendix C	Add Letter of Appendix
Rev. B	Title Page		Revision Level and Date
7-1-78	iii	Record of Revisions	New Format
	iv	Safety Summary	Add
	v, vi	Table of Contents	Added New Page 7-39b
	6-5	Table 6-1	New Part Number for A2J1 (09-15835)
	6-6, 7, 8	Table 6-1	New Part Number for A3U106, Deleted Part Numbers for 13C103, C104, C108, J106, R125-147, U105, U111, U115 - U117 for Units above Serial Number 1714A00490 (09-16291)
	6-10		Correct Part Number for MP1, 2
	7-2, 3, 7, 13, 14, 17, 18	Table 7-1	Changed IC Dictionary for U105, U106, U111, U115 - 177 for Units above Serial Number 1714A00409 (09-16291)
	7-27, 29	Figure 7-2, 3	Change A3 Component Locator to Fit Revision Boards for Units above Serial Number 1714A00490 (09-16280)
	7-37	Figure 7-6a	Change A3 Component Locator and Circuit to Fit Both Rev. A & B Boards (09-16280)
	7-39a	Figure 7-6b	Change A3 Component Locator and Circuit to Fit Only Rev. A Boards (09-16280)
	7-39b	Figure 7-6c	Change A3 Component Locator and Circuit to Fit Only Rev. B Boards (09-16280)

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HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

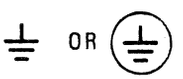
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

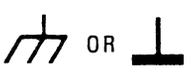
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE: The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual contains installation and operating instructions, and general performance information for the Model 59401A Bus System Analyzer.

1-3. This section of the manual contains a general description and performance specifications of the Model 59401A. Also included in this section are lists of accessories supplied with the 59401A, other accessories available, and instrument and manual identification information.

1-4. DESCRIPTION.

1-5. The Model 59401A Bus System Analyzer is designed to assist the Hewlett-Packard Interface Bus (HP-IB) user in designing hardware as well as diagnosing software and hardware problems. The 59401A acts as a "listener", "talker", "controller", or "systems controller" for complete testing of HP-IB systems.

1-6. SPECIFICATIONS.

1-7. Table 1-1 is a complete listing of the -hp- Model 59401A critical specifications that are controlled by tolerances. Table 1-2 contains general information that describes the operating characteristics of the Model 59401A.

1-8. Any change in the specifications due to manufacturing, design, or traceability to the U.S. National Bureau of Standards will be listed on the manual change sheet included with this manual. The manual and manual change sheet supersede all previous information concerning specifications of the 59401A.

Table 1-1. Specifications.

Listen
- Accept Time: < 750 ns
- Ready Time: < 750 ns

Talk
1) Data changed > 500 ns before DAV pulled low
2) ATN driven low > 1 μs before DAV pulled low
3) DAV driven high < 700 ns after NDAC is false
4) DAV driven low < 700 ns after NRFD is false, if conditions 1 and 2 are met

Power: 100/120/220/240 V + 5%, - 10%, 48 Hz to 66 Hz line operation ≤ 42 VA

Operating Temperature: 0° - 50° C
Storage Temperature: - 40° C - + 75° C
Humidity Range: < 95% R.H. 0° C - 40° C

Table 1-2. General Information.

External Clock Input: 1 standard power TTL gate input. 10 MHz repetition rate.
Compare Output: 1 standard power TTL gate output (LOW TRUE).
HP-IB: 1 Bus load (capable of driving 14 other bus devices).

Height:	14.55 cm (5.73 inches) including feet
	13.28 cm (5.227 inches) without feet
Width:	24.51 cm (9.650 inches) with handles
	20.51 cm (8.075 inches) without handles
Depth:	49.53 cm (19.500 inches) overall length
	42.60 cm (16.775 inches) for rack mounting purposes
Weight:	5.64 kg (12 lb., 7 oz.)

1-9. ACCESSORIES SUPPLIED.

1-10. The following accessories are supplied with the Model 59401A:

One six foot bus cable, -hp- Accessory No. 10631B
One power cable, -hp- Part No. 8120-1538
One extender board, -hp- Part No. 5061-0734

1-11. ACCESSORIES AVAILABLE.

1-12. The following accessories are available for the Model 59401A:

Three foot bus cable, -hp- Accessory No. 10631A
Twelve foot bus cable, -hp- Accessory No. 10631C
Six foot BNC interconnecting cable, -hp- Accessory No. 10519A
Rack Mount Frame, -hp- Part No. 5020-8862
Filler Panel, -hp- Part No. 5061-0006

1-13. Instrument and Manual Identification.

1-14. Instrument identification by serial number is located on the rear panel of the instrument. Hewlett-Packard uses a two section serial number consisting of a four-digit prefix and a five-digit suffix, separated by a letter designating the country in which the instrument was manufactured (A = USA; G = West Germany; J = Japan; U = United Kingdom).

1-15. This manual applies to instruments with the serial numbers shown on the title page. If changes have been made in the instrument since this manual was printed, a "Manual Changes" supplement supplied with the manual will define these changes. Be sure to record these changes in your manual. Backdating information in the back of this manual adapts it to instruments with serial numbers lower than that shown on the title page. Part numbers for the manual and the microfiche copy of the manual are also shown on the title page.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for installing and interfacing the Model 59401A Bus System Analyzer. Included are initial inspection procedures, power and grounding requirements, environmental information, installation instructions, interface connection procedures, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage incurred in transit. If the instrument has been damaged, file a claim with the carrier as soon as possible. Check for supplied accessories (Paragraph 1-9) and test the electrical performance of the instrument using the performance test procedures outlined in Section IV. If there is damage or deficiency, refer to the warranty in the front of this manual.

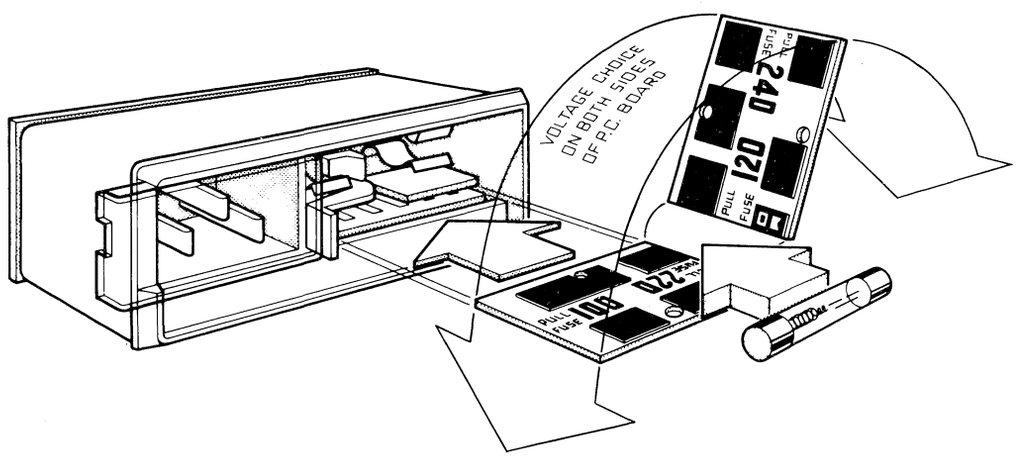
2-5. POWER REQUIREMENTS.

2-6. The Model 59401A can be operated from any power source supplying 100 V, 120 V, 200 V or 240 V (- 10%, + 5%), 48 Hz to 66 Hz. Power dissipation is 42 VA maximum. A circuit board located beneath the power fuse in the power input module is used to select the appropriate voltage operation. The instrument leaves the manufacturer with this circuit board in the 120 V position. To operate the Model 59401A from another voltage, use the following procedure and Figure 2-1.

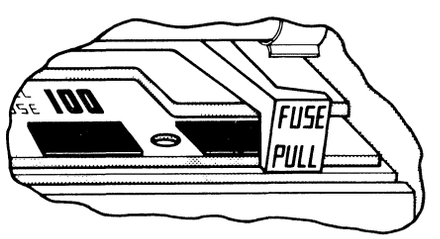
CAUTION

Before switching on this instrument:

Make sure the instrument is set to the voltage of the power source.
Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be **avoided.**



Operating voltage is shown in module window.



SELECTION OF OPERATING VOLTAGE

1. Open cover door and rotate fuse-pull to left.
2. Select operating voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.
3. Rotate fuse-pull back into normal position and insert fuse in holder.

CAUTION

Use correct value of fuse (see Paragraph 2-6g).

Figure 2-1. Power Module.

a. Remove the power cord from the Model 59401A.

b. Slide the plastic power module cover to the left to gain access to the fuse compartment.

c. Remove the line fuse by pulling outward on the fuse puller (see Figure 2-1).

d. Remove the printed circuit board located beneath the fuse holder.

e. Position the circuit board such that the desired operating voltage is on the left side of the upper surface.

f. Replace the circuit board. The selected voltage should be visible after the board is replaced.

g. Install the appropriate line fuse. (For 110/120 volt operation, use a 1A normal blow fuse, -hp- Part No. 2110-0001; for 220/240 volt operation, use a 500 mA normal blow fuse, -hp- Part No. 2110-0012.)

2-7. POWER CORDS.

2-8. Figure 2-2 illustrates the various power cords that are available for the Model 59401A. The part number is shown above each plug drawing. If the appropriate power cord is not included with the instrument, notify the nearest -hp- Sales and Service Office and a replacement power cord will be provided.

2-9. GROUNDING REQUIREMENTS.

2-10. To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 59401A is equipped with a three-wire power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable is the ground connection.

2-11. ENVIRONMENTAL REQUIREMENTS.

2-12. Cooling.

2-13. The Model 59401A is cooled by convection. The instrument should not be mounted in any manner which can obstruct the flow of air around it.

2-14. Operating and Storage Temperature.

2-15. The Model 59401A should not be operated where the ambient temperature range exceeds 0° C (32° F) to 50° C (131° F) or stored where the ambient temperature range exceeds - 40° C (- 40° F) to 75° C (167° F).

2-16. INSTALLATION.

2-17. Bench Use.

2-18. The Model 59401A is shipped with plastic feet and tilt stands in place, ready for use as a bench instrument. The front of the instrument may be elevated for convenience of operating and viewing by lowering the tilt stands.

2-19. Rack Mounting.

2-20. The Model 59401A may be rack mounted by using an adapter frame, -hp- Part No. 5020-8862. This adapter frame fits all standard 19 inch racks and accepts a combination of submodular units for rack mounting only. If only the 59401A is to be rack mounted, the half modular filler panel, -hp- Part No. 5061-0006, is also required.

2-21. INTERFACE CONNECTIONS.

2-22. The Model 59401A is connected to the Hewlett-Packard Interface Bus (HP-IB) with the bus cable provided (-hp- Accessory No. 10631B). This cable is a 24 conductor shielded cable terminated at each end with identical dual blue ribbon connectors. These connectors permit one cable to be plugged into another, eliminating the need for special "Y" or split cables.

2-23. All bus lines may be monitored at test points on the rear panel.

2-24. Two BNC connectors are also provided on the rear panel. The COMPARE OUTPUT, provides a TTL compatible pulse when coincidence occurs between the bus data and the code selected by the front panel DIO switches. The EXT CLOCK input allows the 59401A to be driven at any rate up to maximum HP-IB speed by means of an external signal source.

2-25. REPACKAGING FOR SHIPMENT.

2-26. The following paragraphs contain a general guide for repackaging the instrument for shipment. Refer to Paragraph 2-27 if the original container is to be used; 2-28 if it is not. If you have any questions, contact your nearest -hp- Sales and Service Office (see Appendix A for office locations).

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number.

2-27. Place the instrument in the original container with appropriate packing material and seal well with strong tape or metal bands. If the original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

2-28. If the original container is not to be used, proceed as follows:

a. Wrap the instrument in heavy paper or plastic before placing it in an inner container.

b. Place packing material around all sides of the instrument and protect the panel face with cardboard strips.

c. Place the instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark the shipping container "DELICATE INSTRUMENT", "FRAGILE", etc.

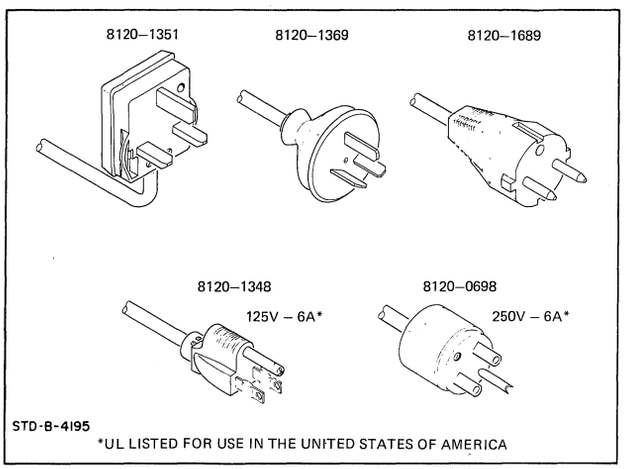


Figure 2-2. Power Cords.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains information and instructions necessary for operation of the -hp- Model 59401A Bus System Analyzer. Included is a functional description of all controls, indicators, and connectors and basic operating procedures and considerations.

3-3. INSTRUMENT CAPABILITIES.

3-4. The Model 59401A is designed to aid HP-IB users in hardware design and in diagnosing hardware and software problems encountered in HP-IB compatible systems. Basically, the 59401A has two modes of operation, as described in the following paragraphs.

3-5. Listen Mode.

3-6. When used as a "listen" device the Model 59401A monitors Bus traffic and can accept and store up to 32 characters from the Bus for later examination, or can be used to compare Bus information to a code selected by the front panel DIO switches. When coincidence occurs between the code selected and the Bus signal, a pulse output is provided at the rear panel COMPARE OUTPUT jack. The 59401A can also be set to stop all Bus traffic when coincidence occurs.

3-7. Talk Mode.

3-8. When used in the "talk" mode the 59401A is used to drive the Bus. The Bus can be driven one character at a time by setting the DIO switches to the appropriate code and outputting this information to the Bus. It is also possible to store a program of up to 32 characters in the 59401A memory and output this information to the Bus at a rate determined by the front panel FAST/SLOW/HALT switch. This switch selects speeds of one character at a time, two characters per second, or full HP-IB system speed.

NOTE

For a description of the Hewlett-Packard Interface Bus, refer to the Hewlett-Packard Interface Bus Abbreviated Description which can be purchased through your local Sales and Service Office under part number 5955-2903. Also available is the pocket-sized HP–IB Quick Reference Card, Part Number 5955-2902.

3-9. CONTROLS AND INDICATORS.

3-10. Figure 3-1 illustrates groups of controls and indicators. These groups are classified according to function. Location and a brief description of individual controls are given in Figure 3-2.

3-11. GENERAL OPERATING INSTRUCTIONS.

3-12. Turn On.

WARNING

Before switching on the instrument, the protective earth terminals of the instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two conductor outlet is not sufficient protection.

Ensure that all devices connected to this instrument are connected to the protective (earth) ground.

3-13. Before connecting ac power to the Model 59401A, make certain the proper operating voltage has been selected to correspond to the voltage of the available power line as outlined in Paragraph 2-6.

3-14. Bus Connection.

3-15. The Model 59401A is connected to the Bus by means of the HP-IB cable provided. Connection can be made at any point on the Bus by plugging this cable into any mating connector on the system cables.

3-16. OPERATING PROCEDURES.

3-17. The following paragraphs describe the basic operating modes of the Model 59401A. These modes are presented in order of operating complexity. To avoid confusion, it is suggested that the operator follow the sequence of operating procedures to familiarize himself with the capabilities of the Model 59401A.

NOTE

For simplicity of explanation, the following operating procedures are written using the Model 59401A to test a system consisting of one or more instruments controlled by an -hp- Model 9820A, 9821A or 9830A Calculator.

However, these operating procedures also ap-

ply to the testing of individual HP-IB compatible devices and systems controlled by devices other than the calculators mentioned, such as, computers, card readers, or another Model 59401A.

3-18. LISTEN MODES.

3-19. The "listen" modes of the Model 59401A are used to monitor signals on the Bus. The three "listen" modes available are LISTEN/HALT, which monitors Bus signals one byte at a time, LISTEN/SLOW, which monitors the Bus signals at a two bytes per second rate, and LISTEN/FAST, which allows the Bus to be monitored at full system speed.

3-20. LISTEN/HALT Mode.

3-21. The LISTEN/HALT mode of the 59401A monitors Bus signals one character at a time. To use this mode, set the front panel switches as follows:

LINE .....ON
REN .....OFF
MEMORY, CLEAR/ON/OFF .....OFF
COMP .....OFF
TALK/LISTEN .....LISTEN
FAST/SLOW/HALT .....HALT

3-22. Clear the Bus by pressing the calculator STOP key. Start the system program by pressing the calculator RUN PROGRAM or RUN, EXECUTE key(s).

3-23. The first program step should be displayed on the 59401A digital readout (both the ASCII character and the octal equivalent). If not, momentarily press the 59401A EXECUTE button.

3-24. The following 59401A indicator lights should be lit:

BUS (Indicating the 59401A is monitoring the Bus.)
ATN (IF the program step is a command, such as a listen or talk address or unaddress code.)
DAV (Indicates the information on the Bus is valid.)
NRFD (Indicates the data has been accepted by one or more instruments on the Bus and that they are not ready for further data at this time.)
NDAC (Indicates that not all units have accepted the data. In this case, the 59401A is usually the last instrument to accept data.)
REN (Permits instruments on the Bus to go to remote control.)

NOTE

For a description of the Hewlett-Packard Interface Bus, refer to the Hewlett-Packard Interface Bus Abbreviated Description which can be purchased through your local Sales and Service Office under part number 5955-2903.

3-25. The "system" program is stepped by momentarily pressing the 59401A EXECUTE button.

NOTE

Data observed on the 59401A digital readout is valid only when the DAV indicator is lit. It is possible for invalid data to be displayed when the EXECUTE button is held in.

3-26. The sequence of Bus control (handshake) signals is as follows:

a. The "talker" puts data on the data lines and drives the DAV line low to indicate the data is valid.

b. The fastest "listener" accepts the data and sets NRFD low.

c. All other instruments on the Bus accept the data at their individual rates.

d. The 59401A accepts the data and allows NDAC to go high when the EXECUTE button is pressed.

e. The "talker" senses NDAC high, sets DAV high, and puts new data on the Bus.

f. Instruments on the Bus become "ready for data" (set NDAC low and NRFD high).

g. The 59401A sets its NDAC output low and allows NRFD to go high when the EXECUTE button is released.

h. The "talker" senses NRFD high and sets DAV low, starting the cycle over.

3-27. LISTEN/SLOW Mode.

3-28. Operation of the 59401A in the LISTEN/SLOW mode is similar to that of the LISTEN/HALT mode, except data on the Bus is automatically read at a two character per second rate.

3-29. To use the LISTEN/SLOW mode to monitor the Bus, set the front panel switches as follows:

LINE .....ON
REN .....OFF
MEMORY, CLEAR/ON/OFF .....OFF
COMP .....OFF
TALK/LISTEN .....LISTEN
FAST/SLOW/HALT .....SLOW

3-30. Clear the Bus by pressing the calculator STOP key and start the system program by pressing the calculator RUN PROGRAM or RUN, EXECUTE key(s).

3-31. The Bus data will automatically be displayed on the 59401A digital readout at two characters per second.

3-32. LISTEN/FAST Mode.

3-33. The LISTEN/FAST mode allows monitoring of the Bus at full system speed or at any rate up to full system speed by using an external signal to drive the rear panel EXTERNAL CLOCK INPUT. To display the Bus data it is necessary to store the Bus information in the 59401A memory and then recall it one character at a time. The following paragraphs describe use of the memory and compare features of the Model 59401A.

3-34. Memory.

3-35. The memory feature of the Model 59401A can be used to store up to 32 bytes of data for later reference or can be used to store a program from the Bus to be later output by the 59401A. The 59401A has a memory capacity of 32 characters (bytes).

3-36. To use the memory feature, first clear the memory by switching the OFF/ON/CLEAR switch to CLEAR and releasing. The memory OFF/ON/CLEAR switch should now be in the ON position. Bus data is now loaded into memory as the 59401A accepts data. Current data is loaded into memory location 31, the previous contents of location 31 are shifted to location 30, the contents of 30 to 29 and so on, leaving the last program byte stored in location 31. If the program is greater than 32 steps, only the last 32 characters will be stored. All previous data will be lost.

3-37. Compare.

3-38. In the LISTEN modes the compare feature (COMP) outputs a pulse at the rear panel COMPARE OUTPUT jack and can be used to halt all Bus traffic when the Bus signal matches the code set on the 59401A lower switch register. A TTL compatible pulse is output in all modes whether the COMP switch is OFF or ON. Bus traffic is halted only when the COMP switch is ON.

3-39. When used with the memory feature, any 32 character segment of a program can be stored by setting the 59401A lower switch register to the code of the last character to be observed and setting the COMP switch to ON. The 59401A will store the program until the program information matches the code selected on the lower switch register and then halt the Bus.

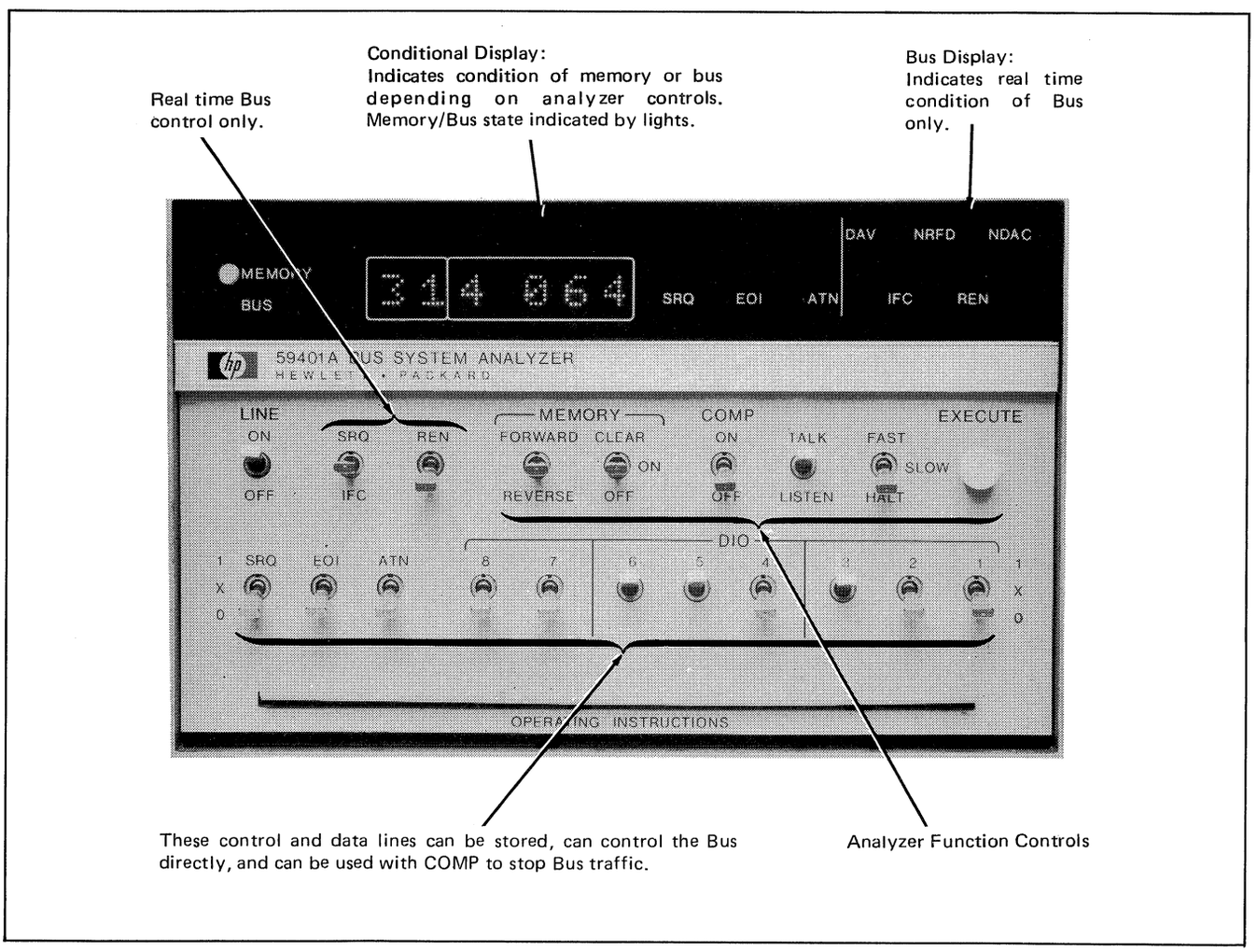


Figure 3-1. Control and Indication Groups.

3-40. When a lower register switch is set to the "X" (don't care) position it automatically matches the corresponding data bit on the Bus.

NOTE

The MEMORY and COMPARE features apply to all "listen" modes but are most commonly used with the LISTEN/FAST mode.

3-41. To use the LISTEN/FAST mode, set the 59401A front panel switches as follows:

LINE ..... ON
REN ..... OFF
MEMORY, CLEAR/ON/OFF .... CLEAR-ON
COMP ..... ON
TALK/LISTEN ..... LISTEN
FAST/SLOW/HALT ..... FAST

Set the lower switch register (SRQ, EOI, ATN, and DIO 1 through 8) to the code of the last character to be observed.

3-42. Clear the Bus by pressing the calculator STOP key and start the system program by pressing the calculator RUN PROGRAM or RUN, EXECUTE key(s).

3-43. The 59401A will automatically halt the Bus when the Bus signal matches the code selected on the lower switch register.

3-44. To display the memory contents, switch the MEMORY FORWARD/REVERSE switch to FORWARD or REVERSE. The first two digits of the display will show the memory location being monitored and the last four digits will show the ASCII character and octal equivalent stored in that location. To step the memory, momentarily switch the FORWARD/REVERSE switch to FORWARD or REVERSE. The 59401A will automatically step the memory at a two character per second rate if this switch is held in FORWARD or REVERSE.

3-45. To monitor another portion of the program, reset the lower switch register to the code of the character desired, momentarily switch the CLEAR/ON/OFF switch to CLEAR and press the EXECUTE button. The 59401A will again store the Bus signals until the code selected matches the Bus data.

NOTE

The MEMORY and COMPARE features do not have to be used in conjunction with one another. The method described in the previous paragraphs is the most common application of these features; however, they may be used separately.

3-46. TALK Modes.

3-47. The Talk modes are used to drive the Bus. The TALK/HALT mode drives the Bus at one character at a time or is used to load program information into the 59401A memory. The TALK/SLOW mode outputs a program stored in memory at a two character per second rate and the TALK/FAST mode outputs the stored program at full system speed.

3-48. TALK/HALT Mode (Memory OFF).

3-49. To use the TALK/HALT mode to output data to the Bus, set the front panel switches as follows:

LINE ..... ON
REN ..... ON
MEMORY, CLEAR/ON/OFF ..... OFF
COMP ..... OFF
TALK/LISTEN ..... TALK
FAST/SLOW/HALT ..... HALT

Insure that the 59401A has control of the Bus by momentarily switching the SRQ/IFC switch to IFC.

CAUTION

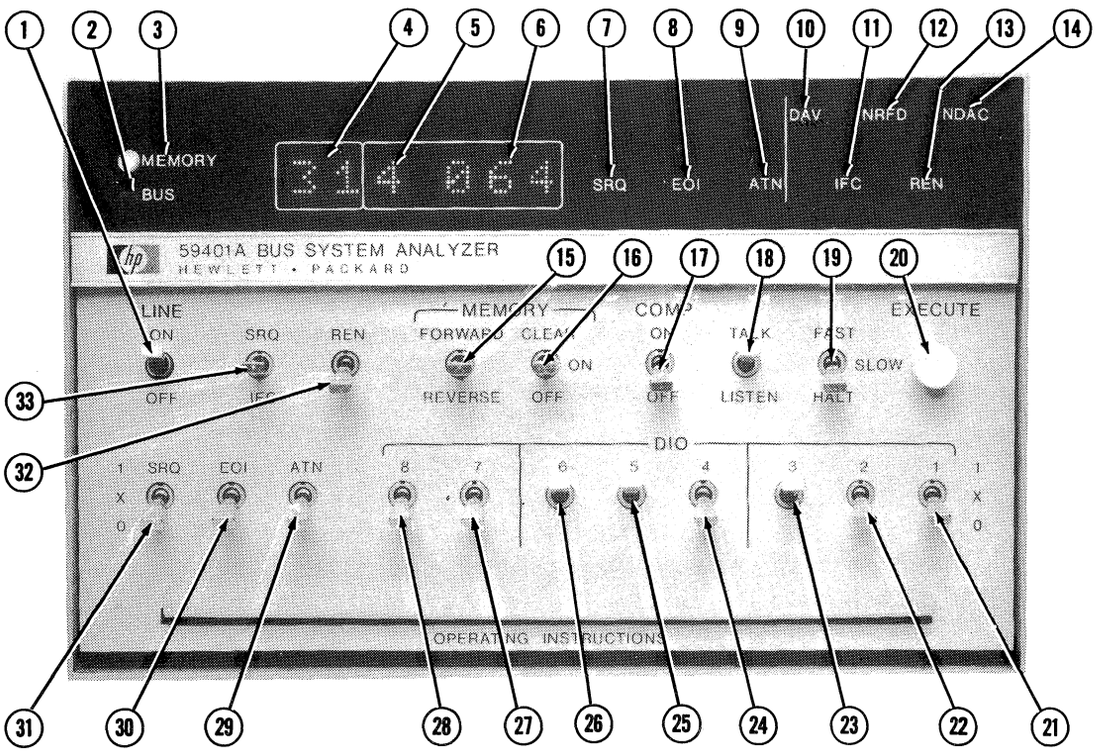
When using the 59401A to test an HP-IB compatible system, it is possible for the 59401A and another instrument on the Bus to be "talking" at the same time. This condition can result in damage to the tri-state output drivers of the 59401A. To insure that no other instrument is talking when the 59401A is to be used to drive the Bus, it is necessary to momentarily switch the SRQ/IFC switch to IFC. When the 59401A is not being used to drive the Bus *it should be placed in one of the "listen" modes or in the TALK/HALT/MEMORY ON mode.*

Set the code of the character to be output to the Bus on the lower switch register (SRQ, EOI, ATN, and DIO 1 through 8).

3-50. The 59401A digital readout will display the ASCII character and the octal equivalent corresponding to the position of the DIO switches. The state of the SRQ, EOI, and ATN switches will be shown by the appropriate indicators.

NOTE

If the display information does not agree with the setting of the front panel switches, it is likely that another instrument on the Bus is driving some of the Bus lines. This condition can be overcome by momentarily switching the 59401A SRQ/IFC switch to IFC. (See the CAUTION in Paragraph 3-49.)



(1) **Line Control.** Switches 59401A power on and off.

(2) **Bus Indicator.** Indicates that the conditional display is disclosing real time Bus information.

(3) **Memory Indicator.** Indicates that the conditional display is disclosing memory contents.

(4) **Memory Location.** Indicates the memory location of the current instruction.

(5) **ASCII Character Indicator.** Displays the ASCII character equivalent to the current octal instruction. For example, "077_8" is displayed as "?".

(6) **Octal Indicator.** Displays the Octal equivalent of the current binary instruction. For example, a Bus or memory instruction of "00 111 111_2" is displayed as "077_8".

(7) **SRQ Indicator.** Lights when the SRQ state is true (subject to condition of Bus/Memory indicators).

(8) **EOI Indicator.** Lights when the EOI state is true (subject to condition of Bus/Memory indicators).

(9) **ATN Indicator.** Lights when the ATN state is true (subject to condition of Bus/Memory indicator).

(10) **DAV Indicator.** Indicates that the active controller has valid data on the Bus lines.

(11) **IFC Indicator.** Lights when the IFC Bus line is in the true state (see also (33)).

(12) **NRFD Indicator.** Indicates that one or more instruments is not ready for data.

(13) **REN Indicator.** Lights when the REN Bus line is in the true state (see also (32)).

(14) **NDAC Indicator.** Indicates that one or more instruments has not accepted the data.

(15) **Forward/Reverse Control.** Increments the memory in the appropriate direction when the 59401A is in LISTEN or TALK, HALT and MEMORY is ON.

(16) **CLEAR/ON/OFF.** All memory locations are set to 000_8 when cleared. When the memory is set to ON and when the 59401A is set to LISTEN or TALK HALT, memory locations can be incremented in the appropriate direction with the FORWARD/REVERSE control.

The memory is also incremented forward by the EXECUTE button when the memory is set to ON, but the information in the lower switch register is first memorized (in the TALK HALT mode). The memory is protected when it is turned off, but it is available to the Bus lines in the TALK, FAST, or SLOW modes.

(17) **COMP Control.** When COMP is set to ON, the data on the Bus is compared to the lower switch register and Bus traffic is stopped when the data matches the settings of the switches. If a switch is set to the "X" (don't care) position, it automatically matches the corresponding data bit on the Bus. When the 59401A is in the talk mode, the COMP, ON function will also stop Bus traffic at memory location 31.

(18) **Talk/Listen Control.** Places the 59401A in either a talk or listen mode.

(19) **FAST/SLOW/HALT.** In the fast mode, the 59401A can interchange information at the maximum system transfer speed. In the slow mode, the 59401A limits Bus speed to two bytes/second. When this switch is set to HALT, information interchange on the Bus is stopped. The halt function is overridden by the EXECUTE control.

Figure 3-2. Controls and Indicators.

(20) **Execute Control.** When EXECUTE is pressed:

a. In LISTEN, HALT, the 59401A accepts one character.

b. In TALK, HALT, MEMORY OFF, the 59401A sends one character.

c. In TALK, HALT, MEMORY ON, the 59401A loads one character into memory.

d. In LISTEN, FAST or SLOW, COMP ON, the 59401A permits Bus traffic to continue.

e. In TALK, FAST or SLOW the 59401A continues sending data.

f. In LISTEN, MEMORY ON (after use of the FORWARD/REVERSE switch has put the 59401A into memory mode), the 59401A leaves the memory mode.

(21) **DIO1 Control*.** This switch controls the 1_2 (1_8) data line.

(22) **DIO2 Control*.** This switch controls the 10_2 (2_8) data line.

(23) **DIO3 Control*.** This switch controls the 100_2 (4_8) data line.

(24) **DIO4 Control*.** This switch controls the 1000_2 (10_8) data line.

(25) **DIO5 Control*.** This switch controls the 10000_2 (20_8) data line.

(26) **DIO6 Control*.** This switch controls the 100000_2 (40_8) data line.

(27) **DIO7 Control*.** This switch controls the 1000000_2 (100_8) data line.

(28) **DIO8 Control*.** This switch controls the 10000000_2 (200_8) data line.

(29) **ATN Control*.** The 59401A can address an instrument or deliver universal commands when this switch is set to the "1" position.

(30) **EOI Control*.** EOI true (1) may indicate the end of a data string or, with ATN true, EOI puts the Bus in the parallel polling mode.

(31) **SRQ Control*.** SRQ calls for the attention of the controller. Typically, this line is used with either the COMP switch or the COMPARE OUTPUT to detect the presence of SRQ in a program.

(32) **REN Control.** Instruments that can be set for remote operation are enabled to do so when this switch is set to REN.

(33) **SRQ/IFC Control.** Setting this switch to IFC stops all communications on the Bus.
Setting this switch to SRQ calls for the attention of the controller.

*The asterisked switches are in the true state when set to the "1" position. These switches are in the false state when set to the "0" position. The "X" (don't care) position is used when comparing the lower switch register to the bus contents. In the "X" position, a comparison is true whether the Bus contains a 1 or a 0. For example, if the DIO switches are set to 00 110 $10X_2$, a comparison will be valid for either 00 110 100_2 or 00 110 101.

Figure 3-2. Controls and Indicators (Cont'd).

3-51. The information set on the lower switch register is output to the Bus by momentarily pressing the 59401A EXECUTE button.

3-52. The "handshake" signal sequence for this mode is as follows:

a. Initially, DAV and NRFD are high and NDAC is low.

b. The 59401A outputs the data set on the lower switch register and sets DAV low when the EXECUTE button is pressed in.

c. The first instrument to accept the data sets NRFD low and NDAC high.

d. All other instruments accept the data, set NRFD low and NDAC high at their particular rate.

e. The last instrument to accept the data sets NDAC high.

f. The 59401A senses NRFD low and NDAC high and sets DAV high when the EXECUTE button is released.

g. When DAV goes high, instruments on the bus set NRFD high and NDAC low at their individual rates, turning the Bus to the initial state.

NOTE

For a description of HP-IB signals, refer to the Condensed Description of the Hewlett-Packard Interface Bus which can be purchased through your local Sales and Service Office.

3-53. TALK/HALT Mode (Memory ON).

3-54. This mode is used to program the 59401A memory. To load information into memory, set the front panel switches as follows:

LINE ..... ON
MEMORY, CLEAR/ON/OFF .... CLEAR-ON
TALK/LISTEN ..... TALK
FAST/SLOW/HALT ..... HALT

Set the memory to location "00" by momentarily switching the FORWARD/REVERSE switch to FORWARD.

3-55. Set the lower switch register to the code of the character to be stored (A list of the available ASCII characters and the octal codes is printed on the front panel "pull out" card.)

3-56. Store the information by pressing the EXECUTE button. When the EXECUTE button is pressed, the digital display shows the memory location and the information being stored in that location. When the EXECUTE button is released the memory is automatically stepped to the next location.

3-57. Repeat the steps in Paragraphs 3-55 and 3-56 until the desired program has been loaded.

3-58. Switch the MEMORY, CLEAR/ON/OFF switch to OFF to protect the memory contents.

3-59. TALK/SLOW Mode.

3-60. The TALK/SLOW mode automatically outputs data from the 59401A memory at two bytes per second. To use this mode, load the desired program in the 59401A memory as outlined in Paragraphs 3-53 through 3-58 and set the front panel switches as follows:

LINE ..... ON
REN ..... ON
MEMORY, CLEAR/ON/OFF ..... OFF
COMP ..... *
TALK/LISTEN ..... TALK
FAST/SLOW/HALT ..... SLOW

*The COMP switch affects the 59401A operation as follows:

a. COMP OFF. The 59401A will continuously output the data stored in memory.

b. COMP ON (all lower register switches set to "0"). The 59401A will output the program data and halt transmission at memory location 31 if the program contains no information matching the lower switch register (octal code 000).

c. COMP ON (lower switch register set to the code of one of the program characters). The 59401A will output the program data until the program information matches the code set on the lower switch register and then halt transmission.

d. COMP ON (all lower register switches set to the "X" position). The 59401A will halt after outputting each program step. This permits transmitting one character at a time from the memory.

NOTE

In all cases the program starts at memory location "00".

To make the 59401A continue outputting the program after it has halted, momentarily press the EXECUTE button.

3-61. The 59401A digital display will show the memory location and the program information stored in that location as it is output to the Bus.

NOTE

If the display indicates the information being output to the Bus disagrees with the information stored in memory, it is possible that another instrument on the Bus is driving some of the Bus lines. This condition can be overcome by momentarily switching the SRQ/IFC switch to IFC. (See the CAUTION in Paragraph 3-49.)

3-62. TALK/FAST Mode.

3-63. Operation of the TALK/FAST mode is the same as the TALK/SLOW mode except the program information is output at full system speed or variable speed if an external source is used to drive the rear panel EXTERNAL CLOCK INPUT. To use this mode follow the procedure outlined in Paragraphs 3-59 through 3-61 with the exception of the FAST/SLOW/HALT switch. This switch should be set to FAST.

3-64. OPERATOR'S MAINTENANCE.

3-65. Fuses.

3-66. The 59401A line fuse is located in the power input module on the rear panel. In addition to replacement, it is necessary to change this fuse when the 59401A is set to operate from a different line voltage (see Paragraph 2-5). To change the fuse, use the following procedure and Figure 2-1.

a. Remove the power cord from the Model 59401A.

b. Slide the plastic power module cover to the left to gain access to the fuse compartment.

c. Remove the line fuse by pulling outward and to the left on the fuse puller.

d. Rotate the fuse puller back to its normal position and insert the proper fuse in the holder. (For 110/120 volt operation, use a 1 A normal blow fuse, -hp- Part No. 2110-0001; for 220/240 volt operation, use a 500 mA normal blow fuse, -hp- Part No. 2110-0012.)

e. Slide the plastic cover to the right and replace the power cord.

3-67. VERIFYING BUS INSTRUMENT INTERFACE FUNCTIONS.

3-68. The Model 59401A is the ideal instrument for verifying that another bus instrument performs its designed interface functions in accordance with IEEE Standard 488-1975. A detailed procedure for performing the verification is given in Appendix A. Any questions the user may have regarding these interface functions are answered in the standard.

3-69. Copies of IEEE Standard 488-1975 may be ordered from:

The Institute of Electrical and Electronic Engineers, Inc.
345 East 47th Street
New York, NY 10017

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section contains performance tests to verify that the Model 59401A is operating within its specifications. The 59401A contains no user maintainable assemblies. For service, contact the nearest -hp- Sales and Service Office. See Appendix B for office locations.

4-3. RECOMMENDED TEST EQUIPMENT.

4-4. Equipment required for the performance tests is listed in Table 4-1, Recommended Test Equipment. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

Table 4-1. Recommended Test Equipment.

Instrument Type	Required Characteristics	Model
Digital Voltmeter	11 volts full scale, ± 3% of reading plus 1 digit	-hp- 3476
Function Generator	100 kHz square wave, 0 to + 5 V, complimentary outputs	-hp- 3310A
Oscilloscope	Dual trace, 50 MHz bandwidth	-hp- 180C
DC Power Supply	+ 5 V dc, 1 amp	-hp- 6213A
Test Load	100 ohm load for each "bus" line	See Figure 4-1

4-5. PERFORMANCE TEST CARD.

4-6. A Performance Test Card is provided at the end of this section for the purpose of recording the results of the Performance Tests. This form lists all of the Performance Tests and their acceptable limits. The form may be removed from the manual and retained as a permanent record of the incoming inspection or routine maintenance performed on the instrument. The Test Card may be reproduced without written permission from Hewlett-Packard.

4-7. PERFORMANCE TESTS.

4-8. The following test verify that your instrument is operating within the specifications outlined in Table 1-1 of this manual. None of these tests require access to the interior of the instrument. If it has been determined, after completing the Performance Tests, that the instrument does not meet one or more of its specifications contact your nearest -hp- Sales and Service Office. See Appendix B for office locations.

NOTE

Do not connect the Model 59401A to the Bus for any of the following Performance Tests.

4-9. Display Indicator Test.

DESCRIPTION:

This procedure tests the operation of the Model 59401A front panel display indicators and individual LED's in the numeric display.

RECOMMENDED TEST EQUIPMENT:

This test does not require the use of any test equipment.

a. Set the lower row of switches to the "0" position. Set the upper switches as follows:

LINE .....ON
SRQ/IFC .....*
REN .....OFF
MEMORY, FORWARD/REVERSE .....*
MEMORY, CLEAR/ON/OFF .....OFF
COMP .....OFF
TALK/LISTEN .....TALK
FAST/SLOW/HALT .....HALT

*Does not apply to test

b. Set the DIO switches as indicated in each step of Table 4-2. Observe that all LED's necessary to make up the character or numeral listed in the "Display" column of Table 4-2 light properly.

c. Switch the MEMORY, CLEAR/ON/OFF switch to ON. The BUS indicator should go off and the MEMORY indicator should come on. The numeric display should show memory location "31".

d. Momentarily switch the MEMORY, CLEAR/ON/OFF switch to CLEAR. The numeric display should show an octal code of "000". There should be no ASCII character displayed. All indicators except the MEMORY indicator should be off.

Table 4-2. Numeric Display Test.

Step	DIO Switch Settings 87 654 321	Display	
		ASCII Character	Octal Code
1	00 000 000		000
2	10 100 100	$	244
3	11 110 110		366
4	11 111 111		377
5	01 001 001	I	111
6	01 001 000	H	110
7	00 100 011	#	043

e. Momentarily switch the MEMORY, FORWARD/REVERSE switch to FORWARD. The numeric display should show memory location "00". Momentarily switch the FORWARD/REVERSE switch to REVERSE. The numeric display should again show memory location "31". Hold the switch in the FORWARD position. The memory location numbers should automatically increase from 00 through 31 at a 2 character per second rate. Hold the switch in the REVERSE position. The memory location numbers should automatically decrease at a 2 character per second rate. Switch the CLEAR/ON/OFF switch to OFF.

f. Switch the SRQ, EOI, and ATN switches to the "1" position. The corresponding display indicators should light. Return the SRQ, EOI, and ATN switches to the "0" position.

g. Switch the SRQ/IFC switch to SRQ. The SRQ indicator should light. Switch to IFC and observe that the IFC indicator lights.

h. Switch the REN switch to REN and observe that the REN indicator lights. Return the REN switch to OFF.

i. Press the EXECUTE button and observe that the DAV indicator lights.

j. Switch the TALK/LISTEN switch to LISTEN. The NDAC indicator should light.

k. Use a clip lead to connect the rear panel DAV and NDAC test points. Press and hold the EXECUTE button. Observe that the NRFD indicator lights. Remove the clip lead.

4-10. Switch Register Test.

DESCRIPTION:

This procedure tests the operation of the front panel control switches and the corresponding rear panel outputs.

RECOMMENDED TEST EQUIPMENT:

Digital Voltmeter, -hp- 3476
DC Power Supply, -hp- 6213A
Test Load, See Figure 4-1

a. Set the lower row of switches to the "0" position. Set the upper switches as follows:

LINE	ON
SRQ/IFC	*
REN	OFF
MEMORY, FORWARD/REVERSE	*
MEMORY, CLEAR/ON/OFF	OFF
COMP	OFF
TALK/LISTEN	TALK
FAST/SLOW/HALT	HALT

*Does not apply to test

b. Connect the ground lead of the voltmeter to the ground lug on the rear panel of the 59401A. Measure the voltage of each test point on the printed circuit board which extends through the rear panel. These readings must be between + 2.4 and + 5.0 V dc.

c. Set all lower switches to the "X" position and again measure the rear panel test points. The voltage readings should be the same as those measured in Step b.

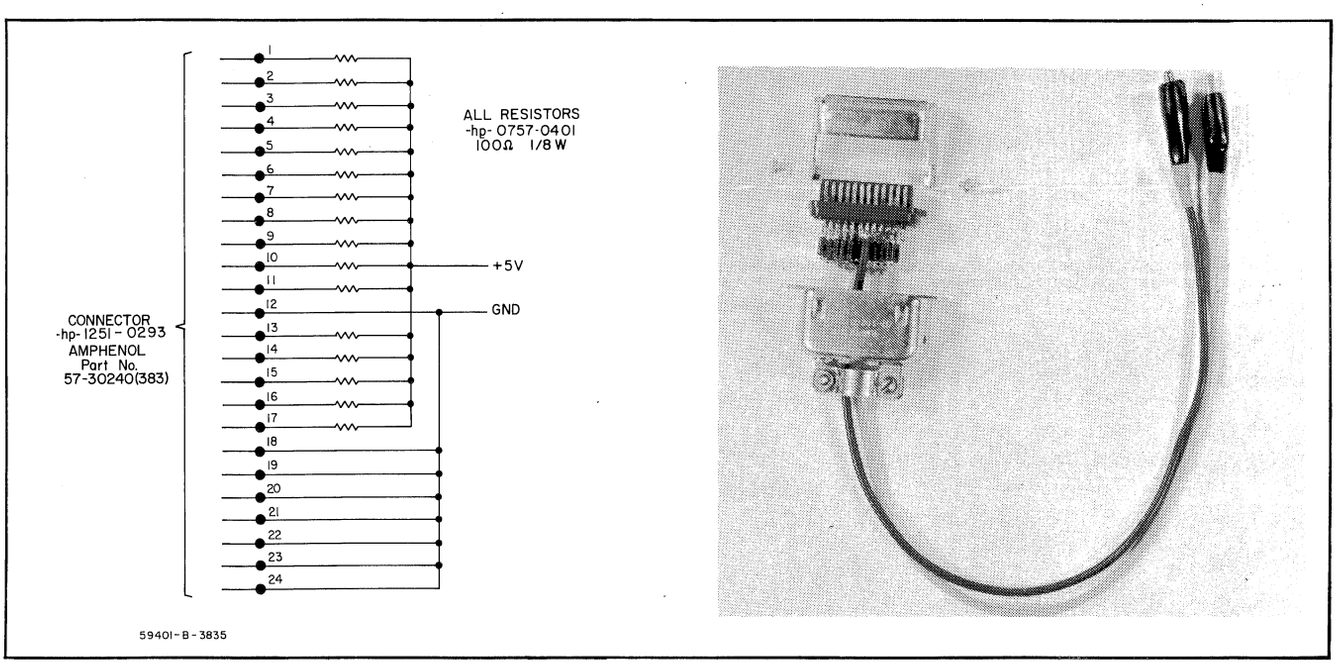


Figure 4-1. Test Load Construction.

d. Adjust the Power Supply for an output of + 5 V dc.

e. Connect the Test Load, described in Figure 4-1, to the rear panel "HP-IB" connector. Connect the Test Load ground lead to the negative output of the Power Supply and the + 5 lead to the positive output.

f. Set all lower switches to the "1" position.

g. Connect the Voltmeter common lead to the ground lead of the Test Load (negative output of the power supply). Measure the rear panel test points DIO 1 through 8 and SRQ, EOI, and ATN. The voltage readings must be less than + 0.4 V dc. Return all lower switches to the "0" position.

h. Hold the SRQ/IFC switch in the IFC position and measure the IFC test point. The voltage reading must be less than + 0.4 V dc.

i. Switch the REN switch to REN and measure the REN test point. The voltage reading must be less than + 0.4 V dc.

j. Press the EXECUTE button and measure the DAV test point. The voltage reading must be less than + 0.4 V dc.

k. Switch the TALK/LISTEN switch to LISTEN and measure the NDAC test point. The voltage reading should be less than + 0.4 V dc.

l. Use a clip lead to connect the rear panel DAV and NDAC test points. Press and hold the EXECUTE button. Measure the NRFD test point. The voltage reading should be less than + 0.4 V dc. Remove the clip lead and Voltmeter test leads.

m. Switch the TALK/LISTEN switch to TALK, the DIO 1 switch to "1", the COMP switch to ON, and the FAST/SLOW/HALT switch to SLOW. The numeric display should begin at memory location "00", count to memory location "31" and then halt. Press the EXECUTE button. The 59401A should repeat this sequence.

n. Remove the Test Load from the 59401A.

4-11. Talk Mode Tests.

DESCRIPTION:

This procedure tests the response time of the 59401A "Handshake" signals when the 59401A is used in the "talk" mode.

NOTE

For a description of the "HP–IB Handshake" signals, refer to the Hewlett-Packard Interface Bus Abbreviated Description which can be purchased through your local Sales and Service Office under part number 5955-2903.

RECOMMENDED TEST EQUIPMENT:

Function Generator, -hp- Model 3310A
Oscilloscope, -hp- Model 180C

a. Set the lower row of switches to the "0" position. Set the upper switches as follows:

LINE	ON
SRQ/IFC	*
REN	OFF
MEMORY, FORWARD/REVERSE	*
MEMORY, CLEAR/ON/OFF	OFF
COMP	OFF
TALK/LISTEN	TALK
FAST/SLOW/HALT	FAST

*Does not apply to test

b. Set the controls of the Function Generator to obtain a 100 kHz square wave. Adjust the OUTPUT LEVEL control for minimum output.

c. Set the Oscilloscope controls for a vertical sensitivity of 2 volts per centimeter, a horizontal sweep speed of 100 nanoseconds per centimeter, and a positive going internal trigger from the channel "B" amplifier.

4-12. Talker Response to NDAC.

a. Connect the Function Generator SYNC OUTPUT to the 59401A rear panel NDAC test point and the HIGH output to the NRFD test point. Adjust the OUTPUT LEVEL and DC OFFSET controls to obtain an amplitude of 0 to + 5 V at the HIGH OUTPUT connector.

b. Connect channel "A" of the Oscilloscope to the 59401A DAV test point, and the channel "B" input to the NDAC test point.

c. The Oscilloscope display should be similar to that shown in Figure 4-2. The time between the positive going edge of the NDAC signal and the positive going edge of the DAV signal must be less than 700 nanoseconds.

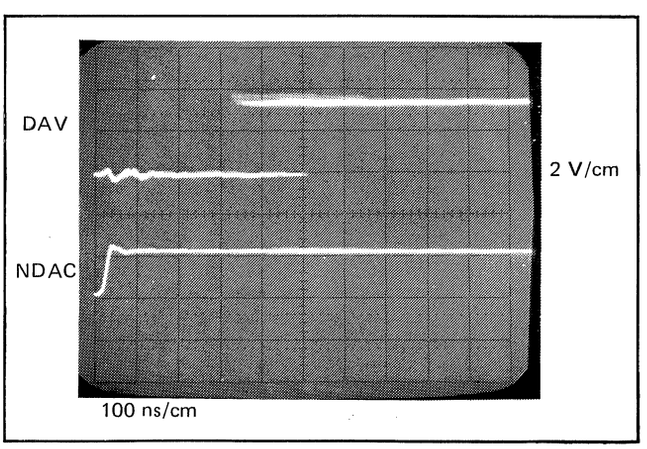


Figure 4-2. Talker Response to NDAC.

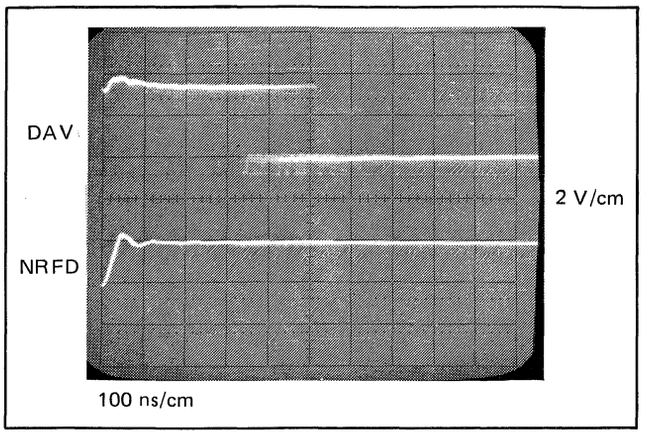


Figure 4-3. Talker Response to NRFD.

4-13. Talker Response to NRFD.

a. Remove the Oscilloscope channel "B" input from the 59401A NDAC test point and connect it to the NRFD test point.

b. The Oscilloscope display should be similar to that shown in Figure 4-3. The time between the positive going edge of the NRFD signal and the negative going edge of the DAV signal must be less than 700 nanoseconds. Remove the Function Generator leads from the 59401A.

4-14. DAV Delay to ATN.

a. Switch the FAST/SLOW/HALT switch to HALT.

b. Switch the MEMORY, CLEAR/ON/OFF switch to CLEAR and release. The memory should now be ON as indicated by the MEMORY indicator.

c. Switch the DIO 1 switch to the "1" position and momentarily press the EXECUTE button. This loads the octal code "001" in memory location 31.

d. Switch the DIO 1 switch to "0", the ATN switch to "1" and momentarily press the EXECUTE button to load ATN in memory location 00.

e. Switch the DIO 1 switch to the "1" position and momentarily press the EXECUTE button to load octal code "001" and ATN in location 01.

f. Switch the MEMORY, CLEAR/ON/OFF switch to OFF and the ATN switch to "0".

g. Connect the Oscilloscope external trigger input to the 59401A COMPARE OUTPUT connector and set the scope to trigger on a positive going external signal.

h. Remove the Oscilloscope channel "B" input from the NRFD test point and connect it to the ATN test point.

i. Switch the FAST/SLOW/HALT switch to FAST.

j. With the Oscilloscope sweep speed set to 200 nanoseconds per centimeter, the display should be similar to that shown in Figure 4-4. The time between the negative going edge of the ATN signal and the negative going edge of the DAV signal should be greater than 1 microsecond.

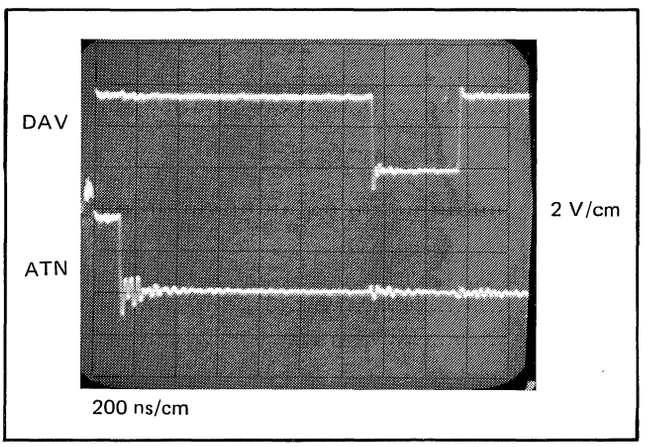


Figure 4-4. DAV Delay to ATN.

4-15. DAV Delay to Data.

a. Remove the Oscilloscope channel "B" input from the ATN test point and connect it to the DIO 1 test point.

b. Set the Oscilloscope to trigger on a negative going external signal.

c. Switch the ATN switch to the "1" position.

d. The Oscilloscope display should be similar to that shown in Figure 4-5. The time between the positive going edge of the DIO 1 signal and the negative going edge of the DAV signal must be greater than 500 nanoseconds.

e. Remove all test equipment connections.

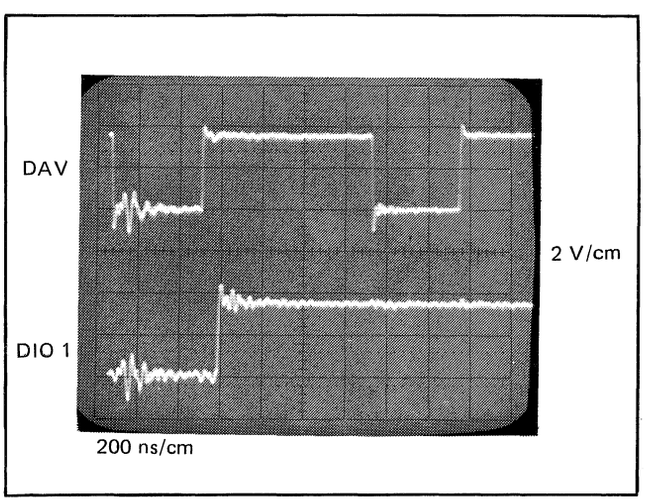


Figure 4-5. DAV Delay to Data.

4-16. Listen Mode Tests.

DESCRIPTION:

This procedure tests the response time of the 59401A to "Handshake" signals when it is used in the "listen" mode.

RECOMMENDED TEST EQUIPMENT:

Function Generator, -hp- Model 3310A
Oscilloscope, -hp- Model 180A
DC Power Supply, -hp- Model 6213A
Test Load, See Figure 4-1

a. Set the lower row of switches to the "0" position. Set the upper switches as follows:

LINE ..... ON
SRQ/IFC ..... *
REN ..... OFF
MEMORY, FORWARD/REVERSE ..... *
MEMORY, CLEAR/ON/OFF ..... OFF
COMP ..... OFF
TALK/LISTEN ..... LISTEN
FAST/SLOW/HALT ..... FAST

*Does not apply to test

b. Set the controls of the Function Generator to obtain a 100 kHz square wave. Adjust the OUTPUT LEVEL control for minimum output.

c. Set the Oscilloscope controls for a vertical sensitivity of 2 volts per centimeter, a horizontal sweep speed of 100 nanoseconds per centimeter, and a negative going internal trigger from the channel "B" amplifier.

d. Adjust the Power Supply for an output of + 5 V dc.

e. Connect the Test Load described in Figure 4-1, to the rear panel "HP-IB" connector. Connect the Test Load ground lead to the negative output of the Power Supply and the + 5 lead to the positive output.

4-17. Listen Accept Time Test.

a. Connect the Function Generator HIGH output to the DAV test point and adjust the OUTPUT LEVEL and DC OFFSET controls for an amplitude of 0 to + 5 V at the HIGH output connector.

b. Connect the Oscilloscope channel "A" input to the NDAC test point and the channel "B" input to the DAV test point.

c. The Oscilloscope display should be similar to that shown in Figure 4-6. The time between the negative going edge of the DAV signal and the positive going edge of the NDAC signal must be less than 750 nanoseconds.

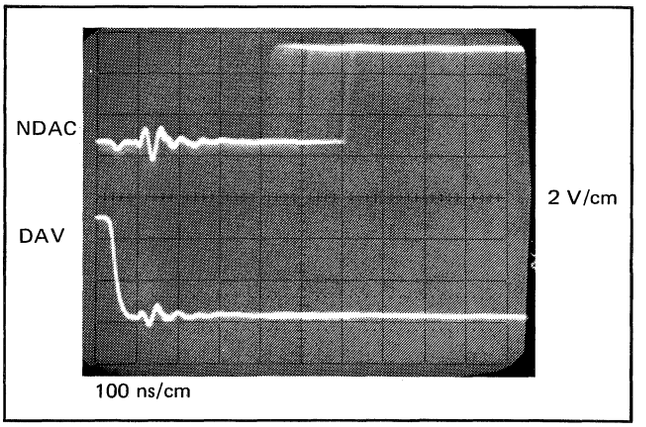


Figure 4-6. Listen Accept Time Test.

4-18. Listen Ready Time Test.

a. Remove the Oscilloscope channel "A" input from the NDAC test point and connect it to the NRFD test point.

b. Set the Oscilloscope to trigger on a positive going internal trigger.

c. The Oscilloscope display should be similar to that shown in Figure 4-7. The time between the positive going edge of the DAV signal and the positive going edge of the NRFD signal must be less than 750 nanoseconds.

d. Remove all test equipment connections.

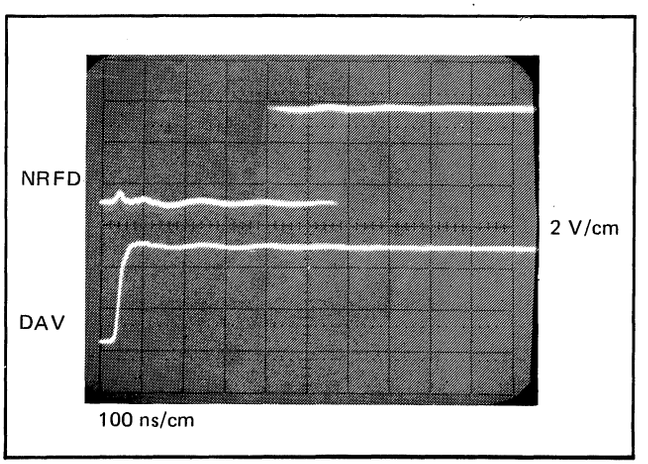


Figure 4-7. Listen Ready Time Test.

PERFORMANCE TEST CARD

Hewlett-Packard Model 59401A
Bus System Analyzer
Serial No. _____

Tests Performed by _____
Date _____

DISPLAY INDICATOR TEST

Step b.

ASCII Character	Pass	Fail	Octal Code	Pass	Fail	Proper LED's Light Pass	Fail
None	____	____	000	____	____	____	____
$	____	____	244	____	____	____	____
None	____	____	366	____	____	____	____
None	____	____	377	____	____	____	____
I	____	____	111	____	____	____	____
H	____	____	110	____	____	____	____
#	____	____	043	____	____	____	____

c. The BUS indicator must go off. Pass _____ Fail _____
The MEMORY indicator must go on. Pass _____ Fail _____
The numeric display must show memory location 31. Pass _____ Fail _____

d. The numeric display must show an octal code of 000. Pass _____ Fail _____
There must be no ASCII character displayed. Pass _____ Fail _____
All indicators, except the MEMORY indicator, must be off. Pass _____ Fail _____

e. The memory advances to location 00. Pass _____ Fail _____
The memory returns to location 31. Pass _____ Fail _____
The memory automatically counts forward. Pass _____ Fail _____
The memory automatically counts backward. Pass _____ Fail _____

f. The SRQ, EOI, and ATN indicators must light when the corresponding switches are in the "1" position. SRQ, Pass _____ Fail _____
EOI, Pass _____ Fail _____
ATN, Pass _____ Fail _____

g. The SRQ and IFC indicators must light when the SRQ/IFC switch is in the appropriate position. SRQ, Pass _____ Fail _____
IFC, Pass _____ Fail _____

h. The REN indicator must light when the REN switch is set to REN. Pass _____ Fail _____

i. The DAV indicator must light when the EXECUTE button is pressed. Pass _____ Fail _____

PERFORMANCE TEST CARD (Cont'd)

j. The NDAC indicator must light when the TALK/LISTEN switch is in the LISTEN position. Pass _____ Fail _____

k. The NRFD indicator must light when the DAV test point is connected to the NDAC test point and the EXECUTE button is pressed.
Pass _____ Fail _____

SWITCH REGISTER TEST

Step

b. All rear panel test points must measure between + 2.4 and + 5.0 V dc.

Test Point	Pass	Fail	Test Point	Pass	Fail
DIO1	_____	_____	ATN	_____	_____
DIO2	_____	_____	EOI	_____	_____
DIO3	_____	_____	SRQ	_____	_____
DIO4	_____	_____	REN	_____	_____
DIO5	_____	_____	IFC	_____	_____
DIO6	_____	_____	NDAC	_____	_____
DIO7	_____	_____	NRFD	_____	_____
DIO8	_____	_____	DAV	_____	_____

c. All readings must remain within the limits in Step b.

g. The following test points must measure less than + 0.4 V dc when the corresponding switches are set to "1".

Test Point	Pass	Fail	Test Point	Pass	Fail
DIO1	_____	_____	DIO7	_____	_____
DIO2	_____	_____	DIO8	_____	_____
DIO3	_____	_____	ATN	_____	_____
DIO4	_____	_____	EOI	_____	_____
DIO5	_____	_____	SRQ	_____	_____
DIO6	_____	_____			

h. The IFC test point reading must be less than + 0.4 V dc when the SRQ/IFC switch is held in the IFC position. Pass _____ Fail _____

i. The REN test point must measure less than + 0.4 V dc when the REN switch is set to REN. Pass _____ Fail _____

j. The DAV test point must measure less than + 0.4 V dc when the EXECUTE button is pressed. Pass _____ Fail _____

k. The NDAC test point must measure less than + 0.4 V dc when the TALK/LISTEN switch is set to LISTEN. Pass _____ Fail _____

l. The NRFD test point must measure less than + 0.4 V dc with the DAV test point connected to the NDAC test point and the EXECUTE button pressed. Pass _____ Fail _____

PERFORMANCE TEST CARD (Cont'd)

m. The memory location must automatically advance to location 31 and halt. Pass _____ Fail _____

This step must repeat when the EXECUTE button is pressed. Pass _____ Fail _____

TALKER RESPONSE TO NDAC

The time between the positive going portion of the NDAC signal and the positive going portion of the DAV signal must be less than 700 nanoseconds. Pass _____ Fail _____

TALKER RESPONSE TO NRFD

The time between the positive going portion of the NRFD signal and the negative going portion of the DAV signal must be less than 700 nanoseconds. Pass _____ Fail _____

DAV DELAY TO ATN

The time between the negative going portion of the ATN signal and negative going portion of the DAV signal must be greater than 1 microsecond. Pass _____ Fail _____

DAV DELAY TO DATA

The time between the positive going portion of the DI01 signal and the negative going portion of the DAV signal must be greater than 500 nanoseconds. Pass _____ Fail _____

LISTEN ACCEPT TIME TEST

The time between the negative going portion of the DAV signal and the positive going portion of the NDAC signal must be less than 750 nanoseconds. Pass _____ Fail _____

LISTEN READY TIME TEST

The time between the positive going portion of the DAV signal and the positive going portion of the NRFD signal must be less than 750 nanoseconds. Pass _____ Fail _____

WARNING

These servicing instructions are for use by trained service personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are trained to do so.

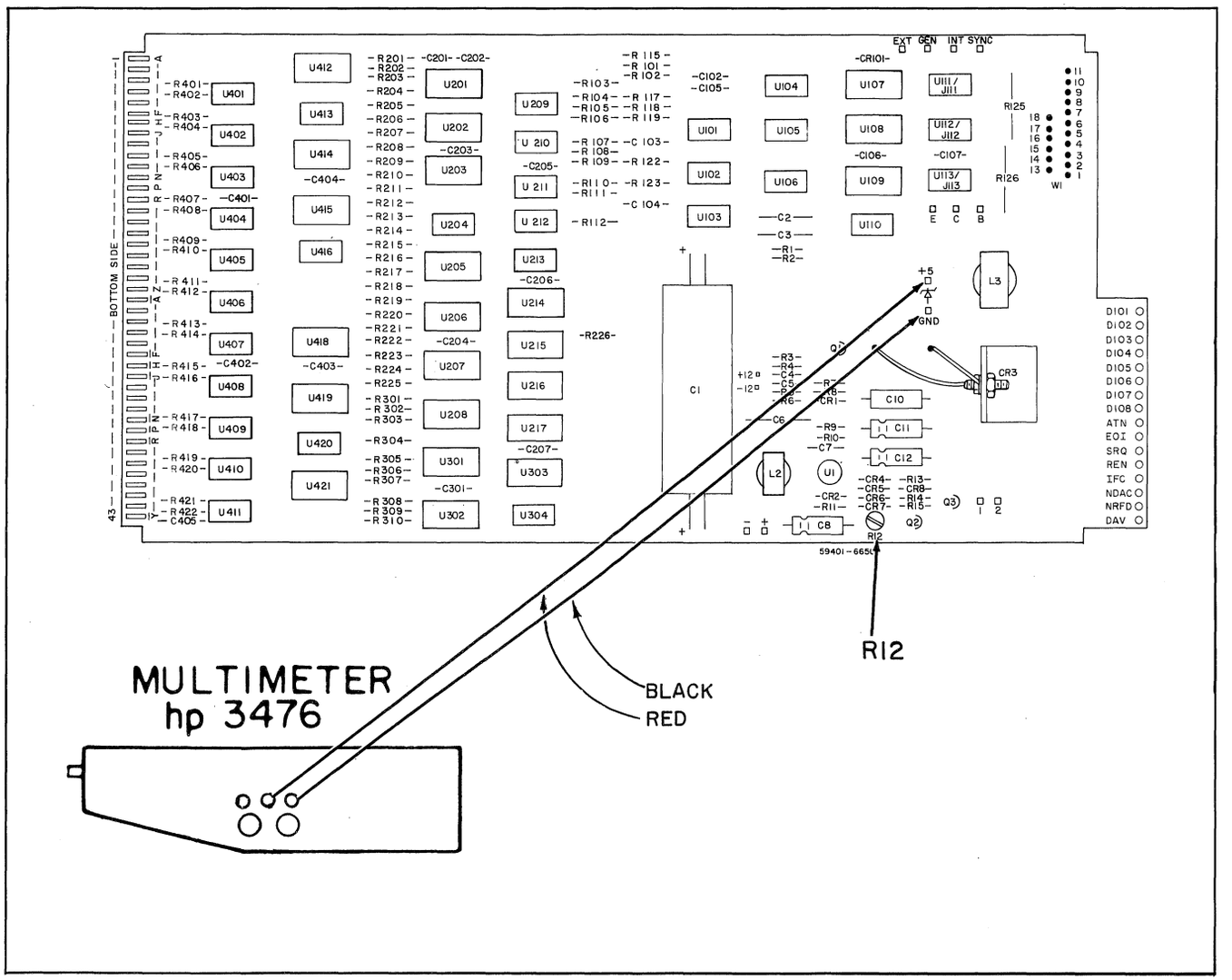


Figure 5-1. +5 Volts Adjustment Connections to A1 Board.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section describes how to make all necessary adjustments to the Model 59401A. If the instrument fails to respond satisfactorily to these adjustments, refer to Section VII for troubleshooting information.

5-3. TEST EQUIPMENT REQUIRED.

5-4. Table 5-1 shows test equipment required. Hewlett-Packard instruments are recommended but any instruments with rated accuracy are acceptable.

Table 5-1. Required Test Equipment.

Item	Accuracy	Recommended
Digital Voltmeter	± .3% of Reading + one digit on 11 V scale	-hp- Model 3476A DMM
Meter Leads	Banana probes on one end, alligator clips on the other	-hp- Model 11002A

5-5. ADJUSTMENTS.

5-6. + 5 Volt Power Supply.

5-7. This procedure explains how to adjust the + 5 volt power supply. It is to be performed by qualified service personnel only. The adjustment is unnecessary if + 5 volts is equal to + 5.1 ± .1 volts.

a. Remove power from the Model 59401A.

WARNING

Failure to perform Step a could result in electrical shock to service personnel or damage to the Model 59401A.

b. Remove the top cover of the Model 59401A using a large Phillips screwdriver.

c. Remove the 6 Phillips head retaining screws from the edges of the top printed circuit board A3.

d. Gently, with fingertips, move the A3 board, now loose, toward the rear of the instrument so that its front end disengages from the connector.

e. Gently lift and tilt sideways the A3 board and remove it from the instrument.

f. Power is still removed.

g. Properly connect meter leads into meter's voltage terminals. The leads should have alligator clips on the dangling ends. Ensure the black lead enters the meter's low terminal.

h. Set the meter to the 10 volt range.

i. Attach the black lead to the "GND" pin and the red lead to the + 5 V pin on the A1 board as shown in Figure 5-1.

j. Turn on the meter.

k. Apply power to the Model 59401A.

l. Using a medium, flat bladed, insulated screwdriver, adjust R12 (see Figure 5-1) until the meter reads + 5.1 volts ± .1 volt.

m. Remove power from the Model 59401A.

n. Turn off the meter.

o. Remove the meter leads.

p. Carefully install the A3 board and plug it into its connector.

q. Install the A3 board's 6 retainer screws and tighten them snugly.

r. Replace the Model 59401A top cover and tighten its fastening screw snugly.

s. Return the Model 59401A to use.

t. Check the + 5 volt supply every six months for the proper voltage.

5-8. There are no other adjustments required.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists in alphanumeric order their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix C for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations. Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

6-8. PARTS CHANGES.

6-9. Components which have been changed are so marked by one of three symbols; ie., Δ, Δ with a letter subcrip, eg., Δ_a, or Δ with a number subscript eg., Δ^{10}_{10}. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript indicates a change which is explained in a note at the bottom of the page. A Δ with a number subscript indicates the related change is discussed in backdating (Section VIII). The number of the subscript indicates the number of the change in backdating which should be referred to.

Standard Abbreviations.

ABBREVIATIONS

Ag ... silver	Hz ... hertz (cycle(s) per second)	NPO ... negative positive zero (zero temperature coefficient)	sl ... slide
Al ... aluminum	ID ... inside diameter	ns ... nanosecond(s) = 10^{-9} seconds	SPDT ... single-pole double-throw
A ... ampere(s)	impg ... impregnated	nsr ... not separately replaceable	SPST ... single-pole single-throw
Au ... gold	incd ... incandescent		
	ins ... insulation(ed)	Ω ... ohm(s)	Ta ... tantalum
C ... capacitor		obd ... order by description	TC ... temperature coefficient
cer ... ceramic	kΩ ... kilohm(s) = 10^{+3} ohms	OD ... outside diameter	TiO_2 ... titanium dioxide
coef ... coefficient	kHz ... kilohertz = 10^{+3} hertz		tog ... toggle
com ... common		p ... peak	tol ... tolerance
comp ... composition	L ... inductor	pA ... picoampere(s)	trim ... trimmer
conn ... connection	lin ... linear taper	pc ... printed circuit	TSTR ... transistor
	log ... logarithmic taper	pF ... picofarad(s) 10^{-12} farads	
dep ... deposited		piv ... peak inverse voltage	V ... volt(s)
DPDT ... double-pole double-throw	mA ... milliampere(s) = 10^{-3} amperes	p/o ... part of	vacw ... alternating current working voltage
DPST ... double-pole single-throw	MHz ... megahertz = 10^{+6} hertz	pos ... position(s)	var ... variable
	MΩ ... megohm(s) = 10^{+6} ohms	poly ... polystyrene	vdcw ... direct current working voltage
elect ... electrolytic	met flm ... metal film	pot ... potentiometer	
encap ... encapsulated	mfr ... manufacturer	p-p ... peak-to-peak	W ... watt(s)
	ms ... millisecond	ppm ... parts per million	w/ ... with
F ... farad(s)	mtg ... mounting	prec ... precision (temperature coeffient, long term stability and/or tolerance)	wiv ... working inverse voltage
FET ... field effect transistor	mV ... millivolt(s) = 10^{-3} volts		w/o ... without
fxd ... fixed	μF ... microfarad(s)		ww ... wirewound
	μs ... microsecond(s)	R ... resistor	
GaAs ... gallium arsenide	μV ... microvolt(s) = 10^{-6} volts	Rh ... rhodium	
GHz ... gigahertz = 10^{+9} hertz	my ... Mylar®	rms ... root-mean-square	* ... optimum value selected at factory, average value shown (part may be omitted)
gd ... guard(ed)		rot ... rotary	** ... no standard type number assigned selected or special type
Ge ... germanium	nA ... nanoampere(s) = 10^{-9} amperes		
gnd ... ground(ed)	NC ... normally closed	Se ... selenium	
	Ne ... neon	sect ... section(s)	® Dupont de Nemours
H ... henry(ies)	NO ... normally open	Si ... silicon	
Hg ... mercury			

DESIGNATORS

A ... assembly	FL ... filter	Q ... transistor	TS ... terminal strip
B ... motor	HR ... heater	QCR ... transistor-diode	U ... microcircuit
BT ... battery	IC ... integrated circuit	R ... resistor	V ... vacuum tube, neon bulb, photocell, etc.
C ... capacitor	J ... jack	RT ... thermistor	W ... cable
CR ... diode	K ... relay	S ... switch	X ... socket
DL ... delay line	L ... inductor	T ... transformer	XDS ... lampholder
DS ... lamp	M ... meter	TB ... terminal board	XF ... fuseholder
E ... misc electronic part	MP ... mechanical part	TC ... thermocouple	Y ... crystal
F ... fuse	P ... plug	TP ... test point	Z ... network

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			ASSEMBLIES		
A1	59401–66501		PC ASSEMBLY–MOTHER BOARD	28480	59401–66501
A2	59401–66502		PC ASSEMBLY–FRONT PANEL BOARD	28480	59401–66502
A3	59401–66503		PC ASSEMBLY–CONTROLLER BOARD	28480	59401–66503
A4	No Part No.*		TRANSISTOR MOUNT ASSEMBLY		
A5	No Part No.*		REAR END ASSEMBLY		
A6	No Part No.*		FRONT END ASSEMBLY		
MP	No Part No.*		MECHANICAL AND OTHER PARTS		
			*See Parts Breakdown		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	59401–66501	1	A1 PC ASSEMBLY–MOTHER BOARD	28480	59401–66501
A1C1	0180–0549	1	CAPACITOR–FXD 4500 μF ± 25% 30 V	09023	
A1C2	0180–1861	1	CAPACITOR–FXD 27 μF ± 10% 10 V	56289	150D276X9010B2
A1C3	0160–0161	1	CAPACITOR–FXD .01μF ± 10% 200 V	56289	292P10392
A1C4, C5	0150–0084	2	CAPACITOR–FXD .1 μF +80–20% 100WVDC	28480	0150–0084
A1C6	0160–0167	1	CAPACITOR–FXD .082 μF ± 10% 200 V	56289	292P82392
A1C7	0180–0291	1	CAPACITOR–FXD 1 μF ± 10% 35 V	56289	150D105X9035A2
A1C8	0180–0113	3	CAPACITOR–FXD 100 μF +20–15% 30 V	56289	109D107C2030T2
A1C10	0180–0159	1	CAPACITOR–FXD 220 μF ± 20% 10 V	56289	150D227X0010S2
A1C11, C12	0180–0113		CAPACITOR–FXD 100 μF +20–15% 30 V	56289	109D107C2030T2
A1C102*	0160–2204	1	CAPACITOR–FXD 100 pF ± 5% 300 V	09023	RDM15F101J3C
A1C103, C104	0180–1704	2	CAPACITOR–FXD 47 μF ± 10% 6 V	56289	150D476X9006B2
A1C105–107	0150–0093	14	CAPACITOR–FXD .01μF +80–20% 100 V	28480	0150–0093
A1C201	0160–2207	1	CAPACITOR–FXD 300 pF ± 5% 300 V	28480	0160–2207
A1C202	0160–2199	1	CAPACITOR–FXD 30 pF ± 5% 300 V	28480	0160–2199
A1C203–C207	0150–0093		CAPACITOR–FXD .01 μF +80–20% 100 V	28480	0150–0093
A1C301	0150–0093		CAPACITOR–FXD .01 μF +80–20% 100 V	28480	0150–0093
A1C401–C405	0150–0093		CAPACITOR–FXD .01 μF +80–20% 100 V	28480	0150–0093
A1CR1	1902–3205	1	DIO–BKDN 15 V	04713	SZ 10939–233
A1CR2	1902–3182	1	DIO–BKDN 12.1 V	04713	SZ10939–206
A1CR3	1901–0511	1	DIO–SI IN3889R	12954	1N3889R
A1CR4–7	1901–0050	4	DIO–SI	28480	1901–0050
A1CR8	1902–3188	1	DIO–BRDN 12.7 V	04713	SZ 10939–213
A1CR101	1902–3085	1	DIO–BKDN 4.75 V	04713	SZ 10939–89
A1J111–J113	1200–0474	3	14 PIN SOCKET IC	28480	1200–0474
A1L2	9100–3232	1	CHOKE 40 μH	28480	9100–3232
A1L3	9100–3231	1	CHOKE 180 μH	28480	9100–3231
A1MP1, MP2	0380–0160	2	STANDOFF–RVT–ON	28480	0380–0160
A1MP3	59401–01203	1	BRKT–DIODE MTG FOR CR3	28480	59401–01203
A1PC1	59401–26501	1	PC BD–MOTHER	28480	59401–26501
A1Q1	1853–0051	1	XSTR–2N4037	02735	2N4037
A1Q2	1854–0039	1	XSTR SI NPN	04713	2N3053
A1Q3	1854–0071	1	XSTR–SI NPN	28480	1854–0071
A1R1	0683–1025	4	RESISTOR–FXD 1000 Ω .05	01121	CB1025
A1R2	0757–0411	1	RESISTOR–FXD 332 Ω .01	24546	C4–1/8–T0–332R–F
A1R3	0683–2015	1	RESISTOR–FXD 200 Ω .05	01121	CB2015
A1R4	0683–1015	11	RESISTOR–FXD 100 Ω .05	01121	CB1015
A1R5	0698–3279	1	RESISTOR–FXD 4990 Ω .01	16299	C4–1/8–T0–4991–F
A1R6	0698–4431	1	RESISTOR–FXD 2050 Ω .01	16299	C4–1/8–T0–2051–F
A1R7	0683–2215	1	RESISTOR–FXD 220 Ω .05	01121	CB2215
A1R8	0683–3015	1	RESISTOR–FXD 300 Ω .05	01121	CB3015
A1R9	0683–0275	1	RESISTOR–FXD 2.7 Ω .05	01121	CB27G5
A1R10	0683–2205	1	RESISTOR–FXD 22 Ω .05	01121	CB2205
A1R11	0683–3915	1	RESISTOR–FXD 390 Ω .05	01121	CB3915
A1R12	2100–1772	1	RESISTOR–VAR 500 Ω .05	GB027	CT–100–4
A1R13	0683–1035	3	RESISTOR–FXD 10 K .05 1/4W	01121	CB1035
A1R14	0683–5115	25	RESISTOR–FXD 510 Ω .05	01121	CB5115
A1R15	0683–0395	1	RESISTOR–FXD 3.9 Ω .05	01121	CB39G5
A1R101–111	0683–5115		RESISTOR–FXD 510 Ω .05	01121	CB5115
A1R112	0683–1025		RESISTOR–FXD 1000 Ω .05	01121	CB1025
A1R115	0683–5115		RESISTOR–FXD 510 Ω .05	01121	CB5115
A1R117	0757–0413	1	RESISTOR–FXD 392 Ω .01	24546	C4–1/8–T0–392R–F
A1R118	0683–2725	34	RESISTOR–FXD 2700 Ω .05	01121	CB2725

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			A1 PC ASSEMBLY (CONT'D)		
A1R119	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A1R122, 123	0683–1005	2	RESISTOR–FXD 10 Ω .05	01121	CB1005
A1R125, 126	1810–0136	2	R–NETWORK	28480	1810–0136
A1R201, 202	0683–1035		RESISTOR–FXD 10 K .05 1/4 W	01121	CB1035
A1R203	0683–1025		RESISTOR–FXD 1000 Ω .05	01121	CB1025
A1R204	0683–5115		RESISTOR–FXD 510 Ω .05	01121	CB5115
A1R205	0683–1025		RESISTOR–FXD 1000 Ω .05	01121	CB1025
A1R206–214	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A1R215–225	0683–5115		RESISTOR–FXD 510 Ω .05	01121	CB5115
A1R226	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A1R301–310	0683–1015		RESISTOR–FXD 100 Ω .05	01121	CB1015
A1R401–422	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A1U1	1820–0196	1	IC–U5R7723393	07263	723HC
A1U101	1820–0621	2	IC–SN7438N	01295	SN7438N
A1U102	1820–1056	1	IC–SN74132	01295	SN74132N
A1U103	1820–0583	14	IC–DM74L00	27014	DM74L00N
A1U104, 105	1820–0618	3	IC–DGTL SN7417N	01295	SN7417N
A1U106	1820–1053	1	IC–SN 7414	01295	SN7414N
A1U107–109	1820–0506	9	IC–DIGITAL	18324	N8266B
A1U110	1820–0621		IC–SN7438N	01295	SN7438N
A1U111–113	1820–1335	3	IC–LINEAR	28480	1820–1335
A1U201	1820–0579	1	IC–DGTL SN74123N	01295	SN74123N
A1U202	1820–1141	1	IC–SN74185	01295	SN74185AN
A1U203	1820–0233	2	IC–SN74193N	01295	SN74193N
A1U204	1820–0054	2	IC–SN7400N	01295	SN7400N
A1U205	1820–0233		IC–SN74193N	01295	SN74193N
A1U206–208	1820–0628	6	IC DGT–SN7489N	01295	SN7489N
A1U209	1820–0577	2	IC–SN7416N	01295	SN7416N
A1U210	1820–0618		IC–DGTL SN7417N	01295	SN7417N
A1U211	1820–0070	1	IC–SN7430N	01295	SN7430N
A1U212	1820–0281	1	IC–DGTL SN74107N	01295	SN74107N
A1U213	1820–0661	1	IC–QUAD SN7432N	01295	SN7432N
A1U214	1820–0301	1	IC–SN7475N	01295	SN7475N
A1U215–217	1820–0628		IC DGT–SN7489N	01295	SN7489N
A1U301–303	1820–0506		IC–DIGITAL	18324	N8266B
A1U304	1820–0577		IC–SN7416N	01295	SN7416N
A1U401–411	1820–0583		IC–DM74L00	27014	DM74L00N
A1U412	1820–0706	1	IC–DGTL–COMPTR	07263	9324DC
A1U413	1820–0054		IC–SN7400N	01295	SN7400N
A1U414	1820–0506		IC–DIGITAL	18324	N8266B
A1U415	1820–0904	2	IC–DGTL–COMPTR	07263	93L24DC
A1U416	1820–0583		IC–DM74L00	27014	DM74L00N
A1U418	1820–0506		IC–DIGITAL	18324	N8266B
A1U419	1820–0904		IC DGTL–COMPTR	07263	93L24DC
A1U420	1820–0583		IC–DM74L00	27014	DM74L00N
A1U421	1820–0506		IC–DIGITAL	18324	N8266B
A1W1	59401–61601	1	CABLE ASSEMBLY–HP–IB	28480	59401–61601

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2	59401–66502	1	A2 PC ASSEMBLY–DISPLAY	28480	59401–66502
A2C1	0180–0197	1	CAPACITOR–FXD 2.2 μF 20 V	56289	150D225X9020A2
A2DS1, DS2	1990–0482	1	DISPLAY–PAIR	28480	1990–0482
A2DS3–DS12	1990–0410	10	DIO–LIGHT EM	28480	1990–0410
A2J1, J2 Δ	1200–0696	2	SOCKET–IC 24 CONT DIP W-WRAP	28480	1200-0696
A2MP1–MP4	0380–0458	4	SPACER–RIVET–ON	28480	0380–0458
A2PC1	59401–26502	1	PC BD–DSPL	28480	59401–26502
A2Q1, Q2	1853–0010	2	XSTR–SI PNP	28480	1853–0010
A2R1–4	0683–2725	4	RESISTOR–FXD 2700 Ω .05	01121	CB2725
A2S1–S11	3101–1834	12	SW–TOGGLE	28480	3101–1834
A2S12	3101–1843	1	SW–PUSHBUTTON	28480	3101–1843
A2S13	3101–1834		SW–TOGGLE	28480	3101–1834
A2S14, S15	3101–1621	3	SW–TGL DPDT	28480	3101–1621
A2S16	3101–1835	1	SW–TOGGLE	28480	3101–1835
A2S17	3101–1836	2	SW–TOGGLE	28480	3101–1836
A2S18	3101–1621		SW–TGL DPDT	28480	3101–1621
A2S19	3101–1836		SW–TOGGLE	28480	3101–1836
A2U1–U4	1858–0014	7	PNP QUAD DRIVER	28480	1858–0014
A2U5	1820–0495	2	IC–SN74154N	07263	9311DC
A2U6–U8	1858–0014		PNP QUAD DRIVER	28480	1858–0014
A2U9	1820–0495		IC–SN74154N	07263	9311DC
A2XA1, XA3	1251–3178	2	CONN–PC EDGE	05574	2VH43/1 & 12(079)

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3	59401–66503	1	A3 PC ASSEMBLY–CONTROLLER	28480	59401–66503
A3C1, C2	0150–0093	22	CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3C3	0180–1704	1	CAPACITOR–FXD 47 μF 6 V	56289	150D476X9006B2
A3C4	0160–2206	1	CAPACITOR–FXD 160 pF 300 V	28480	0160–2206
A3C5	0150–0093		CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3C6	0150–0096	1	CAPACITOR–FXD .05 μF 100 V	28480	0150–0096
A3C7–C14	0150–0093		CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3C15	0180–1701	1	CAPACITOR–FXD 6.8 μF 6 V	56289	150D685X0006A2
A3C16–C18	0150–0093		CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3C20	0160–0205	1	CAPACITOR–FXD 10 pF 500 V	28480	0160–0205
A3C101–102	0150–0093		CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3C103, 104 Δ1a	0150–0093		CAPACITOR–FXD .01 μF +80–20% 100VDC	28480	0150–0093
A3C105	0180–0228	1	CAPACITOR–FXD 22 μF 15 V	56289	150D226X9015B2
A3C106	0150–0093		CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3C107	0150–0121	1	CAPACITOR–FXD .1 μF 50 V	28480	0150–0121
A3C108 Δ1a	0150–0093		CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3C201–206	0150–0084	6	CAPACITOR–FXD .1 μF	28480	0150–0084
A3C207, C208	0150–0093		CAPACITOR–FXD .01 μF 100 V	28480	0150–0093
A3CR1–CR4	1901–0040	4	DIO–SI .05 A 30 V	28480	1901–0040
A3J1, J3, J4	1200–0473	4	SOCKET–IC 16 PIN	28480	1200–0473
A3J15, J16	1200–0431	3	SOCKET–IC 24 PIN	06776	IC–246–S2
A3J25	1200–0469	2	SOCKET–IC 28 PIN	06776	IC–286–S2
A3J26	1200–0431		SOCKET–IC 24 PIN	06776	IC–246–S2
A3J106 Δ1a	1200–0469		SOCKET–IC 28 PIN	06776	IC–286–S2
A3J108	1200–0473		SOCKET–IC 16 PIN	28480	1200–0473
A3PC1	59401–26503	1	PC BOARD–CONT	28480	59401–26503
A3Q1–Q4	1854–0215	4	XSTR–2N3904	04713	SPS 3611
A3Q101–107	1853–0010	7	XSTR–SI PNP	28480	1853–0010
A3R1	0683–3315	13	RESISTOR–FXD 330 Ω .05	01121	CB3315
A3R2	0683–2725	15	RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R3–R5	0683–3315		RESISTOR–FXD 330 Ω .05	01121	CB3315
A3R6	0683–5135	1	RESISTOR–FXD 51 K .05 1/4W	01121	CB5135
A3R7	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R8	0683–1035	14	RESISTOR–FXD 10 K .05 1/4 W	01121	CB1035
A3R9	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R10	0757–0413	2	RESISTOR–FXD 392 Ω .01	24546	C4–1/8–T0–392R–F
A3R11, R12	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R13–R16	0683–1035		RESISTOR–FXD 10 K .05 1/4 W	01121	CB1035
A3R17, R18	0683–1835	2	RESISTOR–FXD 18 K .05 1/4W	01121	CB1835
A3R19, R20	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R21	0683–2025	2	RESISTOR–FXD 2000 Ω .05	01121	CB2025
A3R22	0683–1025	3	RESISTOR–FXD 1000 Ω .05	01121	CB1025
A3R23	0683–1035		RESISTOR–FXD 10 K .05 1/4W	01121	CB1035
A3R24	0683–2025		RESISTOR–FXD 2000 Ω .05	01121	CB2025
A3R25	0683–3315		RESISTOR–FXD 330 Ω .05	01121	CB3315
A3R26	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R27	0683–1025		RESISTOR–FXD 1000 Ω .05	01121	CB1025
A3R28, R29	0683–3335	3	RESISTOR–FXD 33 K .05 1/4W	01121	CB3335
A3R30	0683–6825	1	RESISTOR–FXD 6800 Ω .05	01121	CB6825
A3R31	0683–3335		RESISTOR–FXD 33 K .05 1/4W	01121	CB3335
A3R32	0683–1025		RESISTOR–FXD 1000 Ω .05	01121	CB1025
A3R33, R34	1810–0055	2	R–NETWORK	28480	1810–0055
A3R36	0683–3315		RESISTOR–FXD 330 Ω .05	01121	CB3315
A3R37, R38	0683–1035		RESISTOR–FXD 10 K .05 1/4W	01121	CB1035
A3R101	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R102	0683–2215	7	RESISTOR–FXD 220 Ω .05	01121	CB2215
A3R103	0683–2005	7	RESISTOR–FXD 20 Ω .05	01121	CB2005
A3R104	0683–2215		RESISTOR–FXD 220 Ω .05	01121	CB2215
A3R105	0683–2005		RESISTOR–FXD 20 Ω .05	01121	CB2005
A3R106	0683–2215		RESISTOR–FXD 220 Ω .05	01121	CB2215
A3R107, 108	0683–2005		RESISTOR–FXD 20 Ω .05	01121	CB2005

Δ1a Used on Serial Numbers 1914A00490 and below only.

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			A3 PC ASSEMBLY (CONT'D)		
A3R109, 110	0683–2215		RESISTOR–FXD 220 Ω .05	01121	CB2215
A3R111	0683–2005		RESISTOR–FXD 20 Ω .05	01121	CB2005
A3R112	0683–2215		RESISTOR–FXD 220 Ω .05	01121	CB2215
A3R113	0683–2005		RESISTOR–FXD 20 Ω .05	01121	CB2005
A3R114	0683–2215		RESISTOR–FXD 220 Ω .05	01121	CB2215
A3R115	0683–2005		RESISTOR–FXD 20 Ω .05	01121	CB2005
A3R116	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R117–123	0683–3315		RESISTOR–FXD 330 Ω .05	01121	CB3315
A3R124	0757–0413		RESISTOR–FXD 392 Ω .01	24546	C4–1/8–T0–393R–F
A3R125–128 Δ1a	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3R129–147 Δ1a	0683–2225	19	RESISTOR–FXD 2200 Ω .05	01121	CB2225
A3R201	0683–1005	6	RESISTOR–FXD 10 Ω .05	01121	CB1005
A3R202	0683–1035		RESISTOR–FXD 10 K .05 1/4W	01121	CB1035
A3R203	0683–1005		RESISTOR–FXD 10 Ω .05	01121	CB1005
A3R204	0683–1035		RESISTOR–FXD 10 K .05 1/4W	01121	CB1035
A3R205	0683–1005		RESISTOR–FXD 10 Ω .05	01121	CB1005
A3R206	0683–1035		RESISTOR–FXD 10 K .05 1/4 W	01121	CB1035
A3R207	0683–1005		RESISTOR–FXD 10 Ω .05	01121	CB1005
A3R208, 209	0683–1035		RESISTOR–FXD 10 K .05 1/4W	01121	CB1035
A3R210, 211	0683–1005		RESISTOR–FXD 10 Ω .05	01121	CB1005
A3R212	0683–1035		RESISTOR–FXD 10 K .05 1/4W	01121	CB1035
A3R213	0683–2725		RESISTOR–FXD 2700 Ω .05	01121	CB2725
A3U1	1820–0507	1	IC DGTL–MUVR	18324	N8263B
A3U2	1820–1191	2	IC DGTL–FF	01295	SN74S175N
A3U3	1816–0425	1	IC–MM6331	28480	1816–0425
A3U4	1816–0438	1	ROM BIPOLAR	28480	1816–0438
A3U5,U6	1820–0301	7	IC–SN7475N	01295	SN7475N
A3U7	1820–0054	4	IC–SN7400N	01295	SN7400N
A3U8	1820–0068	1	IC–SN7410N	01295	SN7410N
A3U9	1820–0511	1	IC–SN7408N	01295	SN7408N
A3U10	1820–0661	2	IC–QUAD SN7432N	01295	SN7432N
A3U11	1820–1191		IC DGTL–FF	01295	SN74S175N
A3U12	1820–0579	1	IC–DGTL SN74123N	01295	SN74123N
A3U13, U14	1820–0640	2	IC–SN74150N	01295	SN74150N
A3U15	1818–2233	1	MOS ROM 4 K	28480	1818–2233
A3U16	1818–2234	1	MOS–ROM 4K	28480	1818–2234
A3U17, U18	1820–0077	3	IC–SN7474N	01295	SN7474N
A3U19, U20	1820–0596	2	IC–DGTL DM74L74N	27014	DM74L74N
A3U21	1820–0301		IC–SN7475N	01295	SN7475N
A3U22	1820–0621	1	IC–SN7438N	01295	SN7438N
A3U23, U24	1820–0989	2	IC–SN8271B	18324	N8271B
A3U25	1818–2232	1	MOS ROM 4K	28480	1818–2232
A3U26	1818–2235	1	MOS–ROM 4K	28480	1818–2235
A3U27–U30	1820–0301		IC–SN7475N	01295	SN7475N
A3U31–U34	1820–0586	6	IC–DGTL DM74L04N	27014	DM74L04N
A3U35	1820–0054		IC–SN7400N	01295	SN7400N
A3U101, 102	1820–0620	2	IC–DGTL SN74153N	01295	SN74153N
A3U103, 104	1820–0506	2	IC–DIGITAL	18324	N8266B
A3U105 Δ1a	1820–0491	1	IC–SN74145N	01295	SN74145N
A3U106 Δ1a	1818–0102		IC–TMS–4103	01295	TMS4103NC
A3U106 Δ1b	1816–1300		IC–ROM	28480	1816–1300
A3U107	1820–0586		IC–DGTL DM74L04N	27014	DM74L04N
A3U108	1816–0424	1	IC–MM6331	28480	1816–0424
A3U109	1820–0099	1	IC–SN7493N	01295	SN7493N
A3U110	1820–0077		IC–SN7474N	01295	SN7474N
A3U111 Δ1a	1820–0577		IC–SN7416N	01295	SN7416N
A3U112	1820–1066	1	IC DGTL–GATE	07263	7411PC
A3U113	1820–1053	2	IC–SN7414	01295	SN7414N

Δ1a Used on Serial Numbers 1914A00490 and below only.

Δ1b Used on Serial Numbers 1914A00491 and up only.

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			A3 PC ASSEMBLY (CONT'D)		
A3U114	1820–0661		IC–QUAD SN7432N	01295	SN7432N
A3U115 Δ1a	1820–0618	1	IC–DGTL SN7417N	01295	SN7417N
A3U116 Δ1a	1820–0175	1	IC–SN7405N	01295	SN7405N
A3U117 Δ1a	1820–0586		IC–DGTL DM74L04N	27014	DM74L04N
A3U201	1820–1053		IC–SN 7414	01295	SN7414N
A3U202, 203	1820–0054		IC–SN7400N	01295	SN7400N

Δ1a Used on serial numbers 1714A00490 and below only.

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4			TRANSISTOR MOUNT ASSEMBLY (NOT AVAILABLE AS AN ASSEMBLY)		
CR2	1902–1232	1	DIO–BKDN (1N3997R)	04713	1N3997R
I1	0340–0782	1	INSULATOR, XSTR (FOR Q1)	28480	0340–0782
J1	1200–0456	1	SKT–ELEC	28480	1200–0456
MP1	59401–01202	1	BRACKET, XSTR MOUNT W/FASTENERS	28480	59401–01202
MP2	7120–3185	1	LABEL–WARNING	28480	7120–3185
Q1	1853–0311	1	POWER TRANSISTOR (2N3792)	04713	2N3792

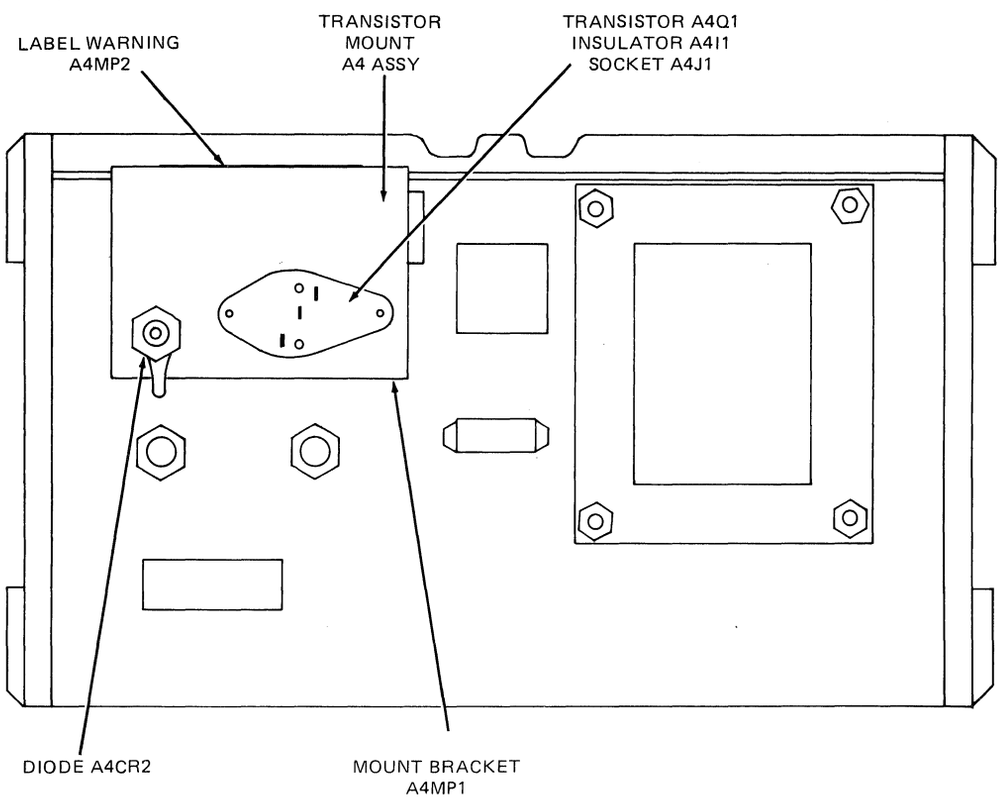


Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A5			A5 REAR END ASSEMBLY (NOT AVAILABLE AS AN ASSEMBLY)		
CR1	1901–0526	1	DIO ASSEMBLY, SI (SA 3337)	28480	1901–0526
F1	2110–0001	1	FUSE 1 AMP NB (110/120 V OPERATION)	71400	AGC–1
F2	2110–0012		FUSE .5 AMP NB (220/240 V OPERATION)	71400	AGC 1/2
J1	1251–3283	1	CONNECTOR, FEMALE, FOR HP–IB CABLE	28480	1251–3283
J2, J3	1250–0083	2	CONN, RF (BNC)	24931	28JR–130–1
MP1, MP2	0380–0643	2	STDF–STUD MT, METRIC, HP–IB CONN	28480	0380–0643
MP1, MP2	0380–1036		STDF–STUD MT, ENGLISH HP–IB	28480	0380–1036
MP3	0590–0075	1	NUT, CAP 4–40 FOR CR1	73734	8060–NP
MP4	4320–0276			28480	4320–0276
MP5	5020–8816	1	FRAME, REAR	28480	5020–8816
MP6	59401–60301	1	PANEL ASSEMBLY, Rear, Including Slide Switch	28480	59401–60301
MP7	5951–7587	1	LABEL–METRIC FOR HP–IB CONN	28480	5951–7587
MP8	7120–3528	1	LABEL–CAUTION	28480	7120–3528
MP9	7122–0058	1	SERIAL PLATE	28480	7122–0058
MP10–13	5040–7213	4	REAR FEET	28480	5040–7213
PM1	0960–0443	1	MODULE, POWER, LINE	28480	0960–0443
T1	9100–3433	1	XFMR–POWER	28480	9100–3433

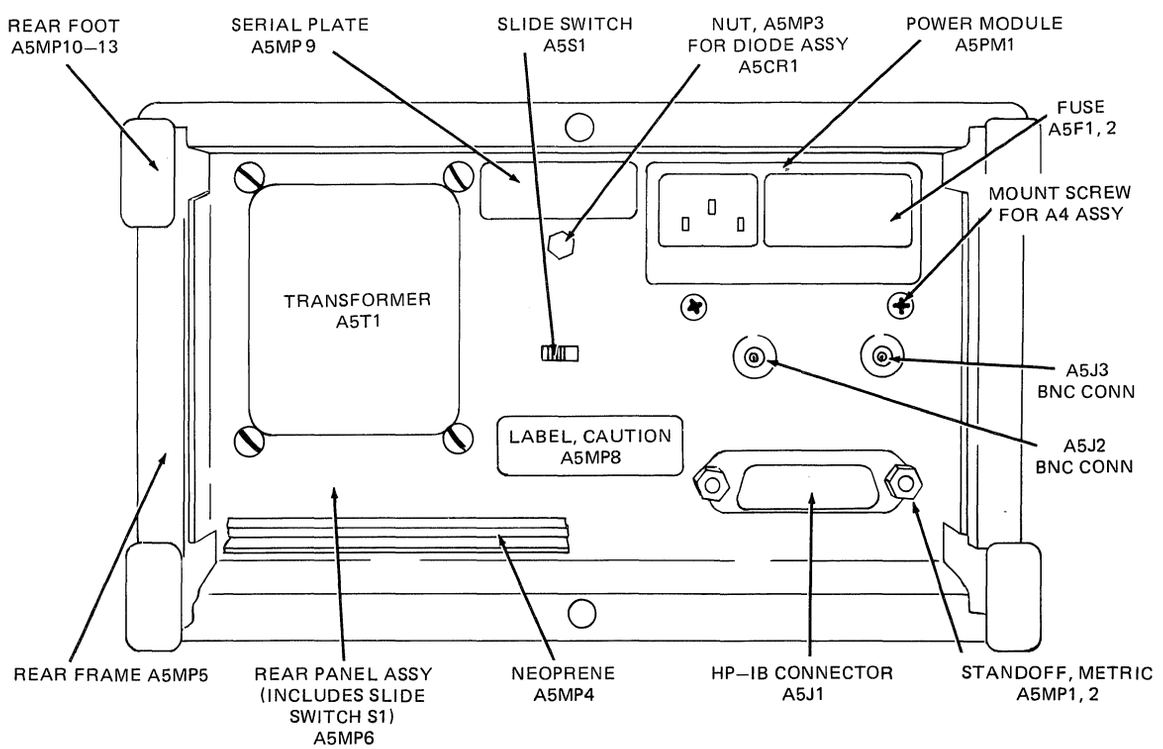


Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A6			FRONT END ASSEMBLY (NOT AVAILABLE AS AN ASSEMBLY)		
MP1	4040–0599	1	DISPLAY WINDOW	28480	4040–0599
MP2	5020–8815	1	FRAME, FRONT	28480	5020–8815
MP3, 4	5020–0896	2	TRIM, SIDE FOR HANDLES	28480	5020–0896
MP5	5040–7203	1	TRIM, TOP	28480	5040–7203
MP6, 7	5060–9899	2	FT HANDLES	28480	5060–9899
MP8	59401–00201	1	PANEL, SWITCH MOUNTING	28480	59401–00201
MP9	59401–24301	1	TRIM STRIP FOR ID LABEL	28480	59401–24301
MP10	59401–24302	1	PANEL, MASK BEHIND WINDOW	28480	59401–24302
MP11	59401–60302	1	PANEL ASSEMBLY FRONT	28480	59401–60302
MP12	7120–4039	1	LABEL, ID	28480	7120–4039
MP13	9320–2262	1	CARD, PULLOUT	28480	9320–2262
MP14, 15	7101–0326	2	RETAINER, PLASTIC FOR TRIM STRIP	28480	7101–0326
MP16	————	1	PUSHBUTTON PART OF A2S12– NOT AVAILABLE SEPARATELY	——	————
S1	59401–61901	1	SW ASSEMBLY, POWER (3101–1694)	28480	59401–61901

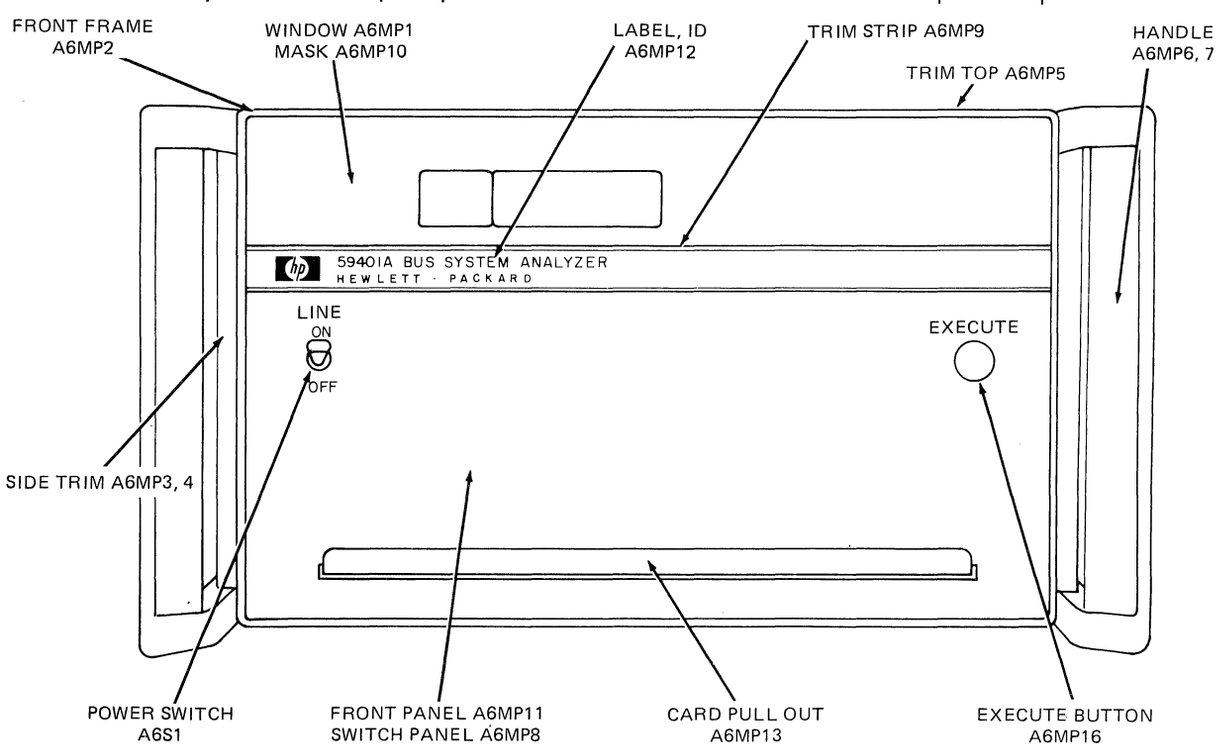
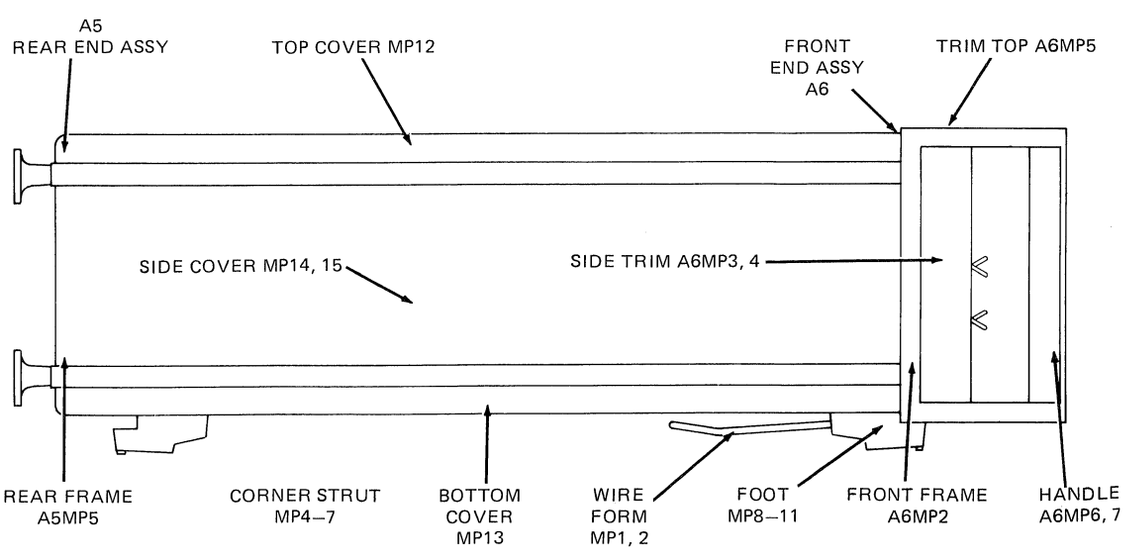


Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			MECHANICAL AND OTHER PARTS		
MP1, 2	1460–1345	2	WIRE FORM FOR BOTTOM FEET	28480	1460–1345
MP3	4040–0633	1	ENVELOPE –INSTRUCTION CARD	28480	4040–0633
MP4–7	5020–8836	4	STRUT, CORNER	28480	5020–8836
MP8–11	5040–7201	4	FOOT, FOR BOTTOM COVER	28480	5040–7201
MP12	5060–9830	1	TOP COVER	28480	5060–9830
MP13	5060–9842	1	BOTTOM COVER	28480	5060–9842
MP14, 15	5060–9856	2	SIDE COVER	28480	5060–9856
MP16–22	59401–01201	7	BRACKET, PC MOUNTING	28480	59401–01201
MP23Δ	7124-2309	1	LABEL, INFORMATION–LAB INST	28480	7120–4614
W1	8120–1538	1	CABLE ASSEMBLY, INPUT POWER	28480	8120–1538
			ACCESSORIES/OPTIONS		
ACC1	5061–0734		PC ASSEMBLY, EXTRA	28480	5061–0734
ACC2*	59401–90030		HP–IB DESCRIPTION MANUAL	28480	59401–90030
ACC 3	8120–1834		CABLE ASSEMBLY HP–IB 1.8 M(6 ft.) 10631B	28480	8120–1834
ACC 4*	8120–1834		CABLE ASSEMBLY HP–IB .9 M (3 ft.) 10631A	28480	8120–1834
ACC 5*	8120–1834		CABLE ASSEMBLY HP–IB 3.7 M (12 ft) 10631C	28480	8120–1834
ACC6	9211–2134		SHIPPING CARTON, CARDBOARD	28480	9211–2134
MP1,2,3,4*	1390–0360	4	LOCKSCREW, METRIC FOR HP–IB CABLE	28480	1390–0360
MP3,4,5,6*	0510–0015	4	RETAINER FOR LOCKSCREW HP–IB CABLE	0018A	1500–12–CD
OPT910*	59401–90001		OPTION 910, EXTRA MANUAL	28480	59401–90001
			*NOT PROVIDED		



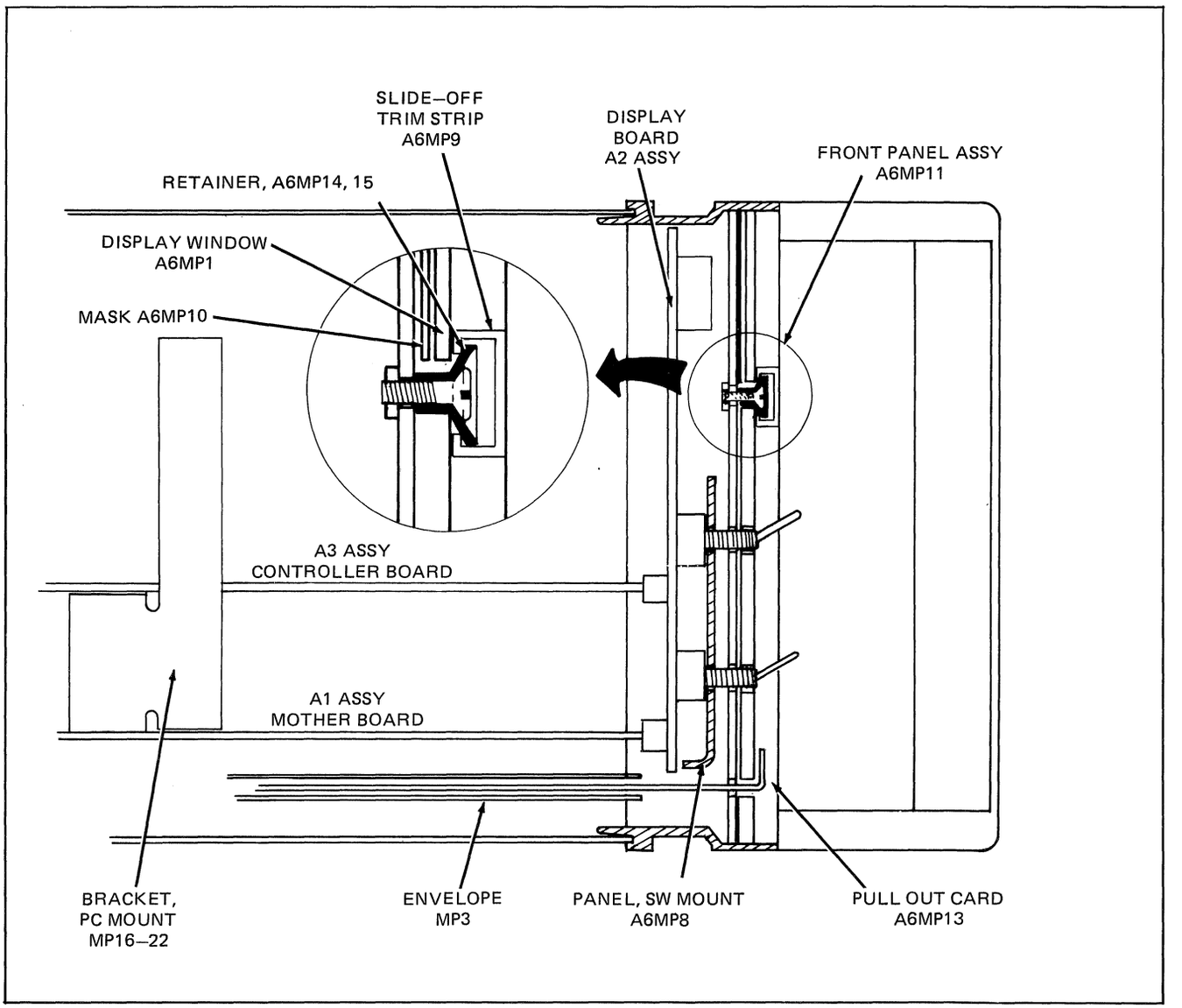


Figure 6-5. Additional Mechanical Parts.

SECTION VII
TROUBLESHOOTING AND CIRCUIT DIAGRAMS

WARNING

All troubleshooting is to be done only by qualified service personnel who are aware of the hazard of exposed voltage terminals.

7-1. INTRODUCTION.

7-2. This section contains the following troubleshooting aids.

a. Block Diagram, Figure 7-1.

b. Schematic Diagrams and component locators, Figures 7-2 through 7-11.

c. Dictionary of Integrated Circuits, including ROM bit patterns, Table 7-1.

7-3. This section contains no theory of operation; however, the theory will be provided as it becomes available. As an interim substitute, use the information in Section III as a guide to studying the block and schematic diagrams and ROM bit patterns. Most circuit functions will thereby become apparent.

7-4. FAILING COMPONENTS.

7-5. The components with the highest history of failure are as follows. They should be checked first in a troubleshooting situation.

a. A1 assembly: Bus drivers U111, 112, 113. (All are in sockets for easy replacement.)

b. Front panel LED indicators.

c. A1 board or A3 board slips out of socket on A2 board when A2 mounting screws are tightened.

d. Most other problems are on the A3 board.

1. Fast controller IC's: U2, 5, 6, 10, 11, 12, 17, 18, 20, 21, 27, 28, 29, 30

2. Open traces between ROM's U15, 16, 25 and 26.

7-6. If any components in the + 5 volt power supply are replaced, perform the + 5 volt power supply adjustment described in Section V.

7-7. ADDITIONAL TROUBLESHOOTING HINTS.

7-8. Additional troubleshooting information will be provided as it becomes available.

Table 7-1. Integrated Circuit Dictionary Including Pin Outs, Logic Diagrams, Truth Tables.

IC TO ITEM NUMBER CROSS REFERENCE

Assy/IC No.	-hp- Part No.	Item No.	IC Type
A1U1	1820–0196	15	IC–U5R7723393
A1U101	1820–0621	31	IC–SN7438N
A1U102	1820–1056	39	IC–SN74132
A1U103	1820–0583	26	IC–DM74L00
A1U104, 105	1820–0618	29	IC–DGTL SN7417N
A1U106	1820–1053	38	IC–SN 7414
A1U107–109	1820–0506	21	IC–DIGITAL
A1U110	1820–0621	31	IC–SN7438N
A1U111–113	1820–1335	43	IC - LINEAR
A1U201	1820–0579	25	IC DGTL SN74123N
A1U202	1820–1141	41	IC SN74185
A1U203	1820–0233	16	IC SN74193N
A1U204	1820–0054	9	IC SN7400N
A1U205	1820–0233	16	IC SN74193N
A1U206–208	1820–0528	32	IC DGT SN7489N
A1U209	1820–0577	24	IC SN7416N
A1U210	1820–0618	29	IC DGTL SN7417N
A1U211	1820–0070	11	IC SN7430N
A1U212	1820–0281	17	IC - DGTL SN74107N
A1U213	1820–0661	34	IC QUAD SN7432N
A1U214	1820–0301	18	IC -SN7475N
A1U215–217	1820–0628	32	IC DGT SN7489N
A1U301–303	1820–0506	21	IC -DIGITAL
A1U304	1820–0577	24	IC- SN7416N
A1U401–411	1820–0583	26	IC -DM74L00
A1U412	1820–0706	35	IC -DGTL–COMPTR
A1U413	1820–0054	9	IC–SN7400N
A1U414	1820–0506	21	IC–DIGITAL
A1U415	1820–0904	36	IC–DGTL–COMPTR
A1U416	1820–0583	26	IC–DM74L00
A1U418	1820–0506	21	IC–DIGITAL
A1U419	1820–0904	36	IC DGTL–COMPTR
A1U420	1820–0583	26	IC–DM74L00
A1U421	1820–0506	21	IC–DIGITAL
A2U1–U4	1858–0014	44	PNP QUAD DRIVER
A2U5	1820–0495	20	IC–SN74154N
A2U6–U8	1858–0014	44	PNP QUAD DRIVER
A2U9	1820–0495	20	IC–SN74154N

IC TO ITEM NUMBER CROSS REFERENCE (Cont'd)

Assy/IC No.	-hp- Part No.	Item No.	IC Type
A3U1	1820–0507	22	IC DGTL–MUVR
A3U2	1820–1191	42	IC DGTL–FF
A3U3	1816–0425	2	IC–MM6331
A3U4	1816–0438	3	ROM BIPOLAR
A3U5,U6	1820–0301	18	IC–SN7475N
A3U7	1820–0054	9	IC–SN7400N
A3U8	1820–0068	10	IC–SN7410N
A3U9	1820–0511	23	IC–SN7408N
A3U10	1820–0661	34	IC–QUAD SN7432N
A3U11	1820–1191	42	IC DGTL- FF
A3U12	1820–0579	25	IC-DGTL SN74123N
A3U13, U14	1820–0640	33	IC–SN74150N
A3U15	1818–2233	6	MOS ROM 4 K
A3U16	1818–2234	7	MOS–ROM 4K
A3U17, U18	1820–0077	12	IC–SN7474N
A3U19, U20	1820–0596	28	IC–DGTL DM74L74N
A3U21	1820–0301	18	IC–SN7475N
A3U22	1820–0621	31	IC–SN7438N
A3U23, U24	1820–0989	37	IC–SN8271B
A3U25	1818–2232	5	MOS ROM 4K
A3U26	1818–2235	8	MOS– ROM 4K
A3U27–U30	1820–0301	18	IC- SN7475N
A3U31–U34	1820–0586	27	IC DGTL DM74L04N
A3U35	1820–0054	9	IC–SN7400N
A3U101, 102	1820–0620	30	IC-DGTL SN74153N
A3U103, 104	1820–0506	21	IC- DIGITAL
A3U105 Δ_{1a}	1820–0491	19	IC SN74145N
A3U106 Δ_{1a}	1818–0102	4a	IC- TMS–4103
A3U106 Δ_{1b}	1816–1300	4b	IC–ROM 3624
A3U107	1820–0586	27	IC–DGTL DM74L04N
A3U108	1816–0424	1	IC–MM6331
A3U109	1820–0099	13	IC–SN7493N
A3U110	1820–0077	12	IC–SN7474N
A3U111 Δ_{1a}	1820–0577	24	IC–SN7416N
A3U112	1820–1066	40	IC DGTL–GATE
A3U113	1820–1053	38	IC–SN7414
A3U114	1820–0661	34	IC–QUAD SN7432N
A3U115 Δ_{1a}	1820–0618	29	IC–DGTL SN7417N
A3U116 Δ_{1a}	1820–0175	14	IC–SN7405N
A3U117 Δ_{1a}	1820–0586	27	IC–DGTL DM74L04N
A3U201	1820–1053	38	IC–SN 7414
A3U202, 203	1820–0054	9	IC–SN7400N

Δ_{1a} Used on serial numbers 1714A00490 and below only.

Δ_{1b} Used on serial numbers 1714A00491 and up only.

ITEM TO PART NUMBER CROSS REFERENCE

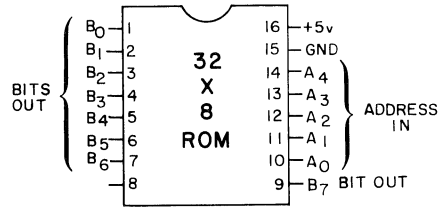
Item No.	Part No.	IC Type	U Number
1	1816-0424	MM6331A	A3U108
2	1816-0425	MM6631B	A3U3
3	1816-0438	ROM Bipolar	A3U4
4a	1818-0102	TMS 4103	A3U106 Δ1a
4b	1818-1300	ROM 3634	A3U106 Δ1b
5	1818-2232	ROM–4K	A3U25
6	1818-2233	ROM–4K	A3U15
7	1818-2234	ROM–4K	A3U16
8	1818-2235	ROM–4K	A3U26
9	1820-0054	SN7400N	A1U204, 413; A3U7, 35, 202, 203
10	1820-0068	SN7410N	A3U8
11	1820-0070	SN7430N	A1U211
12	1820-0077	SN7474	A3U17, 18, 110
13	1820-0099	SN7493	A3U109
14	1820-0175	SN7405N	A3U116
15	1820-0196	723HC	A3U116 Δ1a
16	1820-0233	SN74193N	A1U1
17	1820-0281	SN74107N	A1U203, 205
18	1820-0301	SN7475N	A1U214; A3U5, 6, 21, 27–30
19	1820-0491	SN74145N	A3U105 Δ1a
20	1820-0495	SN74154N	A2U5, 9
21	1820-0506	N8263B	A3U1
22	1820-0507	N8266B	A1U107–109, 301–303, 414, 418, 421; A3U103, 104
23	1820-0511	SN7408N	A3U9
24	1820-0577	SN7416N	A1U209, 304; A3U111 Δ1a, 201
25	1820-0579	SN74123N	A1U201; A3U12
26	1820-0583	DM74L00	A1U103, 401–411, 416, 420
27	1820-0586	DM74L04N	A3U31–34, 107, 117 Δ1a
28	1820-0596	DM74L74N	A3U19, 20
29	1820-0618	SN7417N	A1U104, 105, 210; A3U115 Δ1a
30	1820-0620	SN74153	A3U101, 102
31	1820-0621	SN7438N	A1U101, 110; A3U22
32	1820-0628	SN7489N	A1U206–208, 215–217
33	1820-0640	SN74150N	A3U13, 14
34	1820-0661	SN7432N	A1U213; A3U10, 114
35	1820-0706	9324DC	A1U412
36	1820-0904	93L24DC	A1U415, 419
37	1820-0989	SN8271	A3U23, 24
38	1820-1053	SN7414	A1U106; A3U113, 201
39	1820-1056	SN74132	A1U102
40	1820-1066	7411PC	A3U112
41	1820-1141	SN74S175N	A3U2, 11
42	1820-1191	SN74185	A1U202
43	1820-1335	Linear	A1U111–113
44	1858-0014	Quad PNP	A2U1–4, 6–8

Δ1a Used on serial numbers 1714A00490 and below only.

Δ1b Used on serial numbers 1714A00491 and up only.

(1)

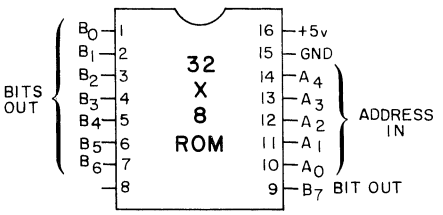
A3U108: MM6331A
1816-0424



Word No. (Decimal)	Octal Address Input	U108 Bit Pattern Output							
		B7	B6	B5	B4	B3	B2	B1	B0
Word 0:	0	0	0	0	0	1	1	1	1
Word 1:	1	0	0	1	0	1	1	1	1
Word 2:	2	0	1	0	0	1	1	1	1
Word 3:	3	0	1	1	0	1	1	1	1
Word 4:	4	0	0	0	0	1	1	1	1
Word 5:	5	0	0	0	1	1	1	1	1
Word 6:	6	0	0	1	1	1	1	1	1
Word 7:	7	0	1	0	1	1	1	1	1
Word 8:	10	0	1	1	1	1	1	1	1
Word 9:	11	1	0	0	1	1	1	1	1
Word 10:	12	0	0	0	0	1	1	0	0
Word 11:	13	0	0	1	0	1	1	0	0
Word 12:	14	0	1	0	0	1	1	0	0
Word 13:	15	0	1	1	0	1	1	0	0
Word 14:	16	1	0	0	0	1	1	0	0
Word 15:	17	0	0	0	1	1	0	1	0
Word 16:	20	0	0	1	1	1	0	1	0
Word 17:	21	0	1	0	1	1	0	1	0
Word 18:	22	0	1	1	1	1	0	1	0
Word 19:	23	1	0	0	1	1	0	1	0
Word 20:	24	0	0	0	1	0	1	1	0
Word 21:	25	0	0	1	1	0	1	1	0
Word 22:	26	0	1	0	1	0	1	1	0
Word 23:	27	0	1	1	1	0	1	1	0
Word 24:	30	1	0	0	1	0	1	1	0
Word 25:	31	0	0	0	1	0	0	1	0
Word 26:	32	0	0	1	1	0	0	1	0
Word 27:	33	0	1	0	1	0	0	1	0
Word 28:	34	0	1	1	1	0	0	1	0
Word 29:	35	1	0	0	1	0	0	1	0
Word 30:	36	1	1	1	1	1	1	1	1
Word 31:	37	1	1	1	1	1	1	1	1

2

A3U3: MM6331B
1816-0425



Word No. (Decimal)	Octal Address Input	U3 Bit Pattern Output							
		B7	B6	B5	B4	B3	B2	B1	B0
Word 0:	0	0	0	0	1	0	1	0	1
Word 1:	1	1	0	0	1	0	1	0	0
Word 2:	2	0	0	0	1	1	1	0	0
Word 3:	3	0	1	0	1	1	1	0	0
Word 4:	4	0	0	1	1	0	1	0	0
Word 5:	5	0	0	0	1	0	1	0	0
Word 6:	6	0	0	0	1	0	1	0	0
Word 7:	7	0	0	0	1	0	1	0	0
Word 8:	10	0	0	0	1	0	1	0	1
Word 9:	11	1	0	0	1	0	1	0	1
Word 10:	12	0	1	0	1	0	1	0	1
Word 11:	13	0	0	0	1	0	1	0	1
Word 12:	14	0	0	1	1	0	1	0	1
Word 13:	15	0	0	0	1	0	1	0	1
Word 14:	16	0	0	0	1	0	1	0	1
Word 15:	17	0	0	0	1	0	1	0	1
Word 16:	20	0	0	0	1	0	1	0	1
Word 17:	21	1	0	0	1	0	1	0	0
Word 18:	22	0	0	0	1	1	1	1	0
Word 19:	23	0	1	0	1	1	1	1	0
Word 20:	24	0	0	1	1	1	1	1	0
Word 21:	25	0	0	0	1	0	1	0	0
Word 22:	26	0	0	0	1	0	1	0	0
Word 23:	27	0	0	0	1	1	1	1	0
Word 24:	30	0	0	0	1	0	0	1	1
Word 25:	31	1	0	0	1	0	1	1	1
Word 26:	32	0	1	0	1	0	1	1	1
Word 27:	33	0	0	0	1	0	1	0	1
Word 28:	34	0	0	1	0	0	1	0	1
Word 29:	35	0	0	0	1	0	1	0	1
Word 30:	36	0	0	0	1	0	1	0	1
Word 31:	37	0	0	0	0	0	1	0	1

Decimal Word	Input Octal Address	Output Bit Pattern B3	B2	B1	BØ
0	000	0	0	1	0
1	001	0	1	0	0
2	002	0	0	1	0
3	003	0	0	0	0
4	004	0	0	1	0
5	005	0	0	0	0
6	006	0	0	1	0
7	007	0	0	0	0
8	010	0	0	1	0
9	011	0	0	0	0
10	012	0	0	1	0
11	013	0	0	0	0
12	014	0	0	1	0
13	015	0	0	0	0
14	016	0	0	1	0
15	017	0	0	0	0
16	020	0	0	1	1
17	021	0	0	0	1
18	022	0	0	1	1
19	023	0	0	0	1
20	024	0	0	1	1
21	025	0	0	0	1
22	026	0	0	1	1
23	027	0	0	0	1
24	030	0	0	1	1
25	031	0	0	0	1
26	032	0	0	1	1
27	033	0	0	0	1
28	034	0	0	1	1
29	035	0	0	0	1
30	036	0	0	1	1
31	037	0	0	0	1
32	040	1	1	1	1
33	041	1	1	1	1
34	042	1	1	1	1
35	043	1	1	1	1
36	044	1	1	1	1
37	045	1	1	1	1
38	046	1	1	1	1
39	047	1	1	1	1
40	050	1	1	1	1
41	051	1	1	1	1
42	052	1	1	1	1
43	053	1	1	1	1
44	054	1	1	1	1
45	055	1	1	1	1
46	056	1	1	1	1
47	057	1	1	1	1
48	060	0	0	0	1
49	061	0	1	1	1
50	062	0	0	0	1

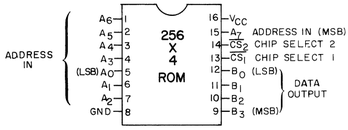
Decimal Word	Input Octal Address	Output Bit Pattern B3	B2	B1	BØ
51	063	0	1	1	1
52	064	0	0	0	1
53	065	0	1	1	1
54	066	0	0	0	1
55	067	0	1	1	1
56	070	0	0	0	1
57	071	0	1	1	1
58	072	0	0	0	1
59	073	0	1	1	1
60	074	0	0	0	1
61	075	0	1	1	1
62	076	0	0	0	1
63	077	0	1	1	1
64	100	1	0	0	1
65	101	0	0	0	1
66	102	1	0	0	1
67	103	0	0	0	1
68	104	1	0	0	1
69	105	0	0	0	1
70	106	1	0	0	1
71	107	0	0	0	1
72	110	1	0	0	1
73	111	0	0	0	1
74	112	1	0	0	1
75	113	0	0	0	1
76	114	1	0	0	1
77	115	0	0	0	1
78	116	1	0	0	1
79	117	0	0	0	1
80	120	0	0	0	1
81	121	0	0	0	1
82	122	0	0	0	1
83	123	0	0	0	1
84	124	0	0	0	1
85	125	0	0	0	1
86	126	0	0	0	1
87	127	0	0	0	1
88	130	0	0	0	1
89	131	0	0	0	1
90	132	0	0	0	1
91	133	0	0	0	1
92	134	0	0	0	1
93	135	0	0	0	1
94	136	0	0	0	1
95	137	0	0	0	1
96	140	0	0	0	1
97	141	0	0	0	1
98	142	0	0	0	1
99	143	0	0	0	1
100	144	0	0	1	1

Decimal Word	Input Octal Address	Output Bit Pattern B3	B2	B1	BØ
101	145	0	0	0	1
102	146	0	0	0	1
103	147	0	0	0	1
104	150	0	0	0	1
105	151	0	0	0	1
106	152	0	0	0	1
107	153	0	0	0	1
108	154	0	0	0	1
109	155	0	0	0	1
110	156	0	0	0	1
111	157	0	0	0	1
112	160	1	0	0	1
113	161	0	1	1	1
114	162	1	0	0	1
115	163	1	1	1	1
116	164	1	0	0	1
117	165	0	1	1	1
118	166	1	0	0	1
119	167	1	1	1	1
120	170	1	0	0	1
121	171	0	1	1	1
122	172	1	0	0	1
123	173	1	1	1	1
124	174	1	0	0	1
125	175	1	0	1	1
126	176	1	0	0	1
127	177	1	1	1	1
128	200	0	0	1	1
129	201	0	0	0	1
130	202	0	0	1	1
131	203	0	0	0	1
132	204	0	0	1	1
133	205	0	1	0	1
134	206	0	0	1	1
135	207	1	1	1	1
136	210	0	0	1	1
137	211	0	0	0	1
138	212	0	0	1	1
139	213	0	0	0	1
140	214	0	0	1	1
141	215	0	1	0	1
142	216	0	0	1	1
143	217	1	1	1	1
144	220	0	0	1	1
145	221	0	0	0	1
146	222	0	0	1	1
147	223	0	0	0	1
148	224	0	0	1	1
149	225	0	0	0	1
150	226	0	0	1	1

Decimal Word	Input Octal Address	Output Bit Pattern B3	B2	B1	BØ
151	227	0	0	0	1
152	230	0	0	1	1
153	231	0	0	0	1
154	232	0	0	1	1
155	233	0	0	0	1
156	234	0	0	1	1
157	235	0	0	0	1
158	236	0	0	1	1
159	237	0	0	0	1
160	240	0	0	0	1
161	241	0	0	0	1
162	242	0	0	0	1
163	243	0	0	0	1
164	244	0	0	0	1
165	245	0	0	0	1
166	246	0	0	0	1
167	247	0	0	0	1
168	250	0	1	0	1
169	251	0	1	0	1
170	252	0	1	0	1
171	253	0	1	0	1
172	254	0	1	0	1
173	255	0	1	0	1
174	256	0	1	0	1
175	257	0	1	0	1
176	260	0	0	0	1
177	261	0	0	0	1
178	262	0	0	0	1
179	263	0	0	0	1
180	264	0	0	0	1
181	265	0	0	0	1
182	266	0	0	0	1
183	267	0	0	0	1
184	270	0	0	0	1
185	271	0	0	0	1
186	272	0	0	0	1
187	273	0	0	0	1
188	274	0	0	0	1
189	275	0	0	0	1
190	276	0	0	0	1
191	277	0	0	0	1
192	300	1	0	0	1
193	301	1	1	1	1
194	302	1	0	0	1
195	303	1	1	1	1
196	304	1	0	0	1
197	305	1	1	1	1
198	306	1	0	0	1
199	307	1	1	1	1
200	310	1	0	0	1

Decimal Word	Input Octal Address	Output Bit Pattern B3	B2	B1	BØ
201	311	1	1	1	1
202	312	1	0	0	1
203	313	1	1	1	1
204	314	1	0	0	1
205	315	1	1	1	1
206	316	1	0	0	1
207	317	1	1	1	1
208	320	0	0	0	1
209	321	0	0	0	1
210	322	0	0	0	1
211	323	0	0	0	1
212	324	0	0	0	1
213	325	0	0	0	1
214	326	0	0	0	1
215	327	0	0	0	1
216	330	0	0	0	1
217	331	0	0	0	1
218	332	0	0	0	1
219	333	0	0	0	1
220	334	0	0	0	1
221	335	0	0	0	1
222	336	0	0	0	1
223	337	0	0	0	1
224	340	0	0	0	1
225	341	0	0	0	1
226	342	0	0	0	1
227	343	0	0	0	1
228	344	0	0	0	1
229	345	0	0	0	1
230	346	0	0	0	1
231	347	0	0	0	1
232	350	0	0	0	1
233	351	0	0	0	1
234	352	0	0	0	1
235	353	0	0	0	1
236	354	0	0	0	1
237	355	0	0	0	1
238	356	0	0	0	1
239	357	0	0	0	1
240	360	1	0	0	1
241	361	0	0	0	1
242	362	1	0	0	1
243	363	0	0	0	1
244	364	1	0	0	1
245	365	1	1	1	1
246	366	1	0	0	1
247	367	1	1	1	1
248	370	1	0	0	1
249	371	0	0	0	1
250	372	1	0	0	1
251	373	0	0	0	1
252	374	1	0	0	1
253	375	1	1	1	1
254	376	1	0	0	1
255	377	1	1	1	1

A3U4 Bipolar ROM
1816–0438

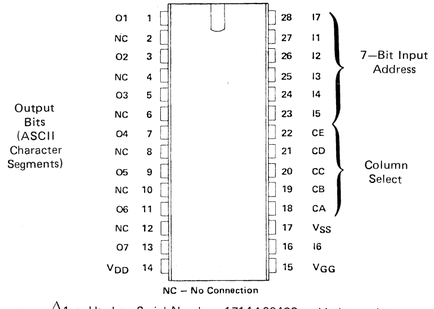


Truth Table

$\overline{CS1}$	$\overline{CS2}$	Input Address	Outputs
0	0	any	ROM Bit Pattern
0	1	any	ROM Bit Pattern
1	0	any	ROM Bit Pattern
1	1	any	All High

4a

A3U106 TMS 4103
1818–0102
5X7–Matrix Driver ROM: Generates 64 USASCII Characters

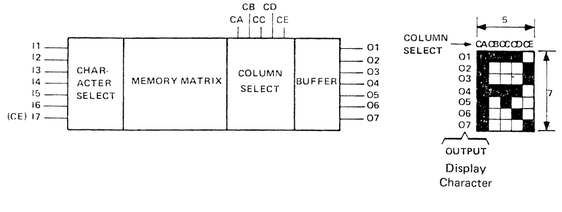


Δ_{1a}: Used on Serial Numbers 1714A00490 and below only.

The TMS 4103 generates 64 USASCII characters for driving a 5 x 7 matrix display. Output buffers are open-drain and are capable of driving Series 74 TTL circuits without external resistors. All inputs can be driven directly from Series 74 TTL circuits.

The five 7-bit column words appear on O1 through O7 as column select inputs CA through CE are strobed in sequence with a high level pulse. The device is enabled with a high level on I7.

functional block diagram



4b

A3U106, 1816-1300 INTEL 3624
256X8 ROM

Δ_{1b}: Used on Serial Numbers 1714A00491 and up only.

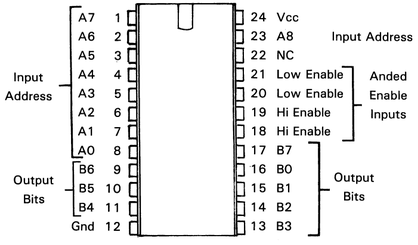


Table of ROM Contents

Address	Contents								Address	Contents							
	XX0	XX1	XX2	XX3	XX4	XX5	XX6	XX7		XX0	XX1	XX2	XX3	XX4	XX5	XX6	XX7
00X	101	076	042	052	103	377	377	377	40X	177	177	177	177	177	377	377	377
01X	100	067	067	067	100	377	377	377	41X	177	177	006	177	177	377	377	377
02X	000	066	066	066	111	377	377	377	42X	177	017	177	017	177	377	377	377
03X	101	076	076	076	135	377	377	377									
04X	000	076	076	135	143	377	377	377	43X	153	000	153	000	153	377	377	377
									44X	155	125	000	125	133	377	377	377
05X	000	066	066	066	076	377	377	377	45X	034	033	167	154	034	377	377	377
06X	000	067	067	067	077	377	377	377	46X	171	106	062	115	172	377	377	377
07X	101	076	076	066	120	377	377	377	47X	157	137	077	177	177	377	377	377
10X	000	167	167	167	000	377	377	377									
11X	177	076	000	076	177	377	377	377	50X	177	143	135	076	177	377	377	377
									51X	177	076	135	143	177	377	377	377
12X	175	176	176	176	001	377	377	377	52X	153	167	101	167	153	377	377	377
13X	000	167	153	135	076	377	377	377	53X	167	167	101	167	167	377	377	377
14X	000	176	176	176	176	377	377	377	54X	177	162	161	177	177	377	377	377
15X	000	137	147	137	000	377	377	377									
16X	000	117	167	171	000	377	377	377	55X	167	167	167	167	167	377	377	377
									56X	177	174	174	177	177	377	377	377
17X	101	076	076	076	101	377	377	377	57X	174	173	167	157	037	377	377	377
20X	000	067	067	067	117	377	377	377	60X	101	072	066	056	101	377	377	377
21X	101	076	072	075	102	377	377	377	61X	156	136	000	176	176	377	377	377
22X	000	067	063	065	116	377	377	377									
23X	115	066	066	066	131	377	277	377	62X	134	072	066	066	116	377	377	377
									63X	135	076	066	066	111	377	377	377
24X	077	077	000	077	077	377	377	377	64X	163	153	133	000	173	377	377	377
25X	001	176	176	176	001	377	377	377	65X	015	056	056	056	061	377	377	377
26X	017	163	174	163	017	377	377	377	66X	141	126	066	066	071	377	377	377
27X	000	175	163	175	000	377	377	377									
30X	034	153	167	153	034	377	377	377	67X	077	070	067	057	037	377	377	377
									70X	111	066	066	066	111	377	377	377
31X	017	167	160	167	017	377	377	377	71X	116	066	066	065	103	377	377	377
32X	074	072	066	056	036	377	377	377	72X	177	111	111	177	177	377	377	377
33X	000	076	076	177	177	377	377	377	73X	177	022	021	177	177	377	377	377
34X	037	157	167	173	174	377	377	377									
35X	177	177	076	076	000	377	377	377	74X	167	153	135	076	177	377	377	377
									75X	153	153	153	153	153	377	377	377
36X	137	077	077	077	137	377	377	377	76X	177	076	135	153	167	377	377	377
37X	176	176	176	176	176	377	377	377	77X	137	077	072	067	117	377	377	377

OCTAL ADD	BIT PATTERN MSB ◄ ► LSB
000	1111111101100011
001	1101111101100011
002	1110111101110111
003	1110111101100011
004	1111111111100011
005	1111111111110111
006	1101111101110111
007	1111011116100001
010	1111111101110111
011	1110011101100001
012	1011011110110001
013	1010611110100001
014	1110111101001011
015	1110011110100001
016	1110111101001011
017	1111011110110001
020	1010011110110001
021	1000111111100011
022	1111111111100111
023	1111011111100111
024	1011011110110001
025	1000011111100011
026	1010611101000011
027	0101011101100001
030	1011011110110001
031	1101011101100011
032	1110011101100011
033	1111011101100011
034	1110011101100011
035	1101011101100611
036	1110011101100011
037	1111011101100611
040	0101011101100011
041	1110101011100001
042	1010101011100001
043	1100101011100001
044	1101101011100001
045	1111101011100000
046	1010101011100001
047	1111101101100011
050	1111101111100000
051	1111101111100011
052	1000101111100011
053	1111101111100001
054	0011101111100001
055	1111101111100001
056	1111101111000011
057	1111101111000001
060	1111101111000001
061	1001101111000001
062	1111101111000001
063	1111111111100011
064	1000111111100011
065	1111111111100011
066	1000111111100011
067	1110111101100011
070	1111011111100001
071	1110611116100001
072	1010011110100001
073	0110011101100001
074	1111011101100001
075	0100011113100601
076	1010011110100001
077	0101011101100001
100	1110011101100001
101	1111111111100011
102	1090111111100011
103	1101111191100011
104	1010011110100001
105	1110011110100001
106	0101011110100001
107	1111011110110101
110	1111011110100001
111	1110011110100001
112	1111111111100011
113	1000111111100011
114	0011011110100001
115	1111111101100011
116	1110111101000011
117	1101111101100011
120	1100111101100011
121	0111111101100011
122	1111111101000011
123	1101111101100011
124	0111111101100011
125	1111111111100000
126	1111111111100011
127	1000111111100011
130	1101111101000011
131	1110111101100011
132	1111111101000011
133	1111101011110111
134	1111111111100000
135	1111111111100011
136	1000111111100011
137	1111111101100001
140	1111101111100001
141	0011101111100001
142	1111101111100001
143	1100111111100011
144	1111111111100011
145	1111111111100001
146	1111101111000001
147	1111101111000001
150	1001101111000001
151	1101111101100011
152	1111101011100000
153	1111111101100011
154	1101101011100011
155	1010111101100011
156	1101100111100001
157	1100101111100001
160	1010101111100001
161	1111111111100011
162	1000111111100011
163	0111111101100011
164	1010111101100011
165	1111111111100011
166	1000111111100011
167	1101111101000011
170	1111111101000011
171	1111111101000011
172	1110111101100011
173	1101111101100011
174	1010110101100011
175	1010111101100011
176	1111110101160000
177	1101111101100011
200	1111110101100000
201	0011110101100011
202	1101111101100011
203	1111111101100011
204	1111111101100111
205	1111111101111011
206	1111111101100011
207	1111111101100011
210	1110111101100011
211	1101111101100011
212	1011111101110011
213	1010111101100011
214	1111111101100111
215	1110111101100011
216	1101111101100011
217	1111111101100111
220	1010111101101011
221	1111101011111111
222	1011111101110011
223	1111110101100011
224	1011111101110011
225	1111110101100011
226	1110110101100011
227	1101110101100011
230	1100110101100011
231	1100110101100011
232	1111110101100111
233	1010110101100011
234	1110110101100011
235	1101110101100011
236	1011110101110011
237	1100101111100001
240	1111110101100111
241	1111111101100011
242	1111111101000011
243	1111111111100011
244	1000111111100011
245	1111111101100111
246	1010111101101011
247	1010110101110011
250	1111111111100111
251	1011110101100111
252	1010101111100001
253	1110101111100001
254	1101101111100001
255	1000111111100011
256	0111111111100111
257	1000111111100011
260	1111101111101001
261	1111101111100001
262	0011101111100001
263	1111011111100001
264	1100111101000011
265	1000111111100011
266	1111101111000001
267	1001101111000001
270	1111101111000001
271	1111111101100011
272	1111111111100000
273	1111111111100011
274	1000111111100011
275	1011110101100011
276	1111110101100111
277	1111111101000011
300	1011110101110011
301	1111111101000011
302	1111111101000111
303	1111111101000011
304	1011110101100111
305	1000111111100011
306	1011110101110011
307	1000101111100001
310	1111111101100111
311	1110111101000011
312	1111111101100111
313	1111111101000011
314	1111111101000011
315	1111101111100001
316	1000111111100011
317	1111110101101011
320	1111110101110011
321	1111110101110011
322	1111111101110011
323	1111111101111011
324	1011111101100011
325	1011011110100001
326	1111111101100011
327	0111111101100011
330	1111110101100011
331	0111110101100011
332	1011011110110101
333	1110111101000011
334	0111111101000011
335	1111111111100011
336	1111111111100011
337	1111111111000011
340	1100111101000011
341	1101111101100011
342	1010111101100011
343	1100101111100001
344	1111101111100001
345	1111101111000001
346	1111011110100001
347	0101011110100001
350	1111111101000111
351	1111111101000011
352	1011111101000011
353	1111111101100000
354	1111110101100011
355	1111110101110011
356	1111111101100011
357	1111110101110011
360	1111111101100011
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366	1111111101100011
367	1111111101100011
370	1111111101100011
371	1111111101100011
372	1111111101100011
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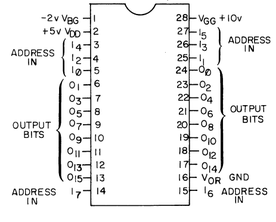
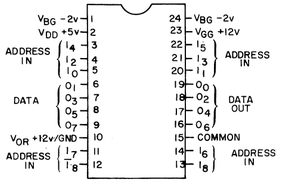
375	1111111101100011
376	1111111101100011
377	1111111101100011

A3U25 ROM 256X16
1818–2232



A3U15 ROM 512X8
1818–2233

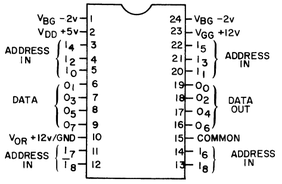


NOTE

If Both I8 and $\overline{I8}$ are high the output bits are all high.

OCTAL ADD	BIT PATTERN MSB◄—►LSB
000	00000010
001	10010001
002	01001101
003	00000110
004	00000111
005	00000100
006	00100501
007	00010109
010	00111000
011	00011000
012	00001100
013	00001101
014	00010110
015	00011000
016	00111001
017	00000111
020	11010101
021	00010010
022	00010001
023	00010101
024	00010010
025	00010011
026	00010111
027	01001100
030	00010011
031	00100001
032	00011011
033	00000010
034	00011101
035	00100001
036	00011111
037	00000010
040	00011101
041	00100010
042	00100011
043	00101110
044	00100111
045	00100110
046	11001101
047	00101000
050	00101001
051	00101010
052	00101000
053	00101100
054	00101101
055	00101011
056	00101111
057	00110002
060	00110001
061	00113010
062	00110000
063	00110100
064	00110011
065	00110110
066	00110101
067	00111000
070	00111001
071	01000001
072	00111011
073	00111100
074	00111101
075	01000100
076	00111111
077	00111111
100	01000001
101	01000010
102	01000001
103	00100001
104	01000101
105	01000001
106	11100110
107	01001000
110	00009111
111	11011010
112	01301011
113	01001010
114	00111001
115	01001110
116	01001111
117	01010101
120	01011000
121	01001101
122	01010011
123	01011100
124	10000010
125	01010110
126	01010111
127	01010101
130	11011011
131	01111010
132	10110100
133	10010101
134	01011101
135	01011110
136	01011100
137	01010101
140	01100001
141	01100010
142	01100000
143	11011111
144	01100101
145	01100000
146	01101000
147	01100110
150	01100111
151	01101100
152	01101100
153	01010000
154	01101101
155	00300000
156	01011111
157	01100011
160	01110101
161	01110010
162	01110001
163	01113100
164	01101011
165	01110110
166	01110101
167	01111001
170	01111001
171	00000000
172	01111011
173	01111100
174	01001101
175	01010010
176	01111100
177	10000001
200	10000001
201	01010010
202	01001101
203	01001101
204	10000110
205	10000100
206	10006111
207	10001011
210	10010100
211	10001010
212	10001100
213	00000000
214	11110001
215	01101100
216	10001111
217	10011001
220	11010100
221	10010011
222	00000000
223	10010101
224	01010010
225	10011001
226	11000110
227	10011110
230	10011110
231	10011010
232	10100001
233	11000010
234	11001010
235	10011010
236	11101100
237	11100101
240	10100001
241	10100010
242	11101010
243	10100100
244	10100011
245	11010000
246	10101001
247	10010101
250	10101101
251	10101001
252	10101110
253	10110000
254	10111001
255	10101000
256	10101111
257	10101110
260	01101110
261	10110010
262	10110011
263	10110001
264	11011101
265	10110101
266	10110111
267	10111000
270	10110110
271	10111010
272	10111011
273	10111100
274	10111010
275	01011011
276	11101111
277	01001110
300	10111110
301	11000011
302	11000001
303	00000000
304	11003010
305	11000101
306	11101000
307	11000111
310	11001011
311	11100000
312	11001100
313	10111111
314	11001001
315	00100001
316	11001110
317	11010001
320	10100110
321	10010101
322	10010000
323	10000111
324	11010100
325	11010101
326	11010111
327	11010011
330	11011001
331	11001111
332	11100111
333	11011100
334	01011010
335	11011110
336	01100011
337	01100111
340	10110100
341	01011111
342	00050000
343	11100100
344	10011111
345	10111000
346	11100111
347	11100111
350	11101001
351	01010010
352	11100011
353	11100011
354	11101101
355	10010101
356	00006000
357	10000111
360	00000000
361	10016101
362	00000000
363	00000260
364	00000000
365	00000900
366	00004200
367	00000000
370	00000000
371	00000000
372	00000000
373	00000000
374	00000000
375	00000000
376	00000000
377	00000000
400	00000011
401	10010001
402	01001101
403	00000101
404	00000111
405	00000100
406	00100001
407	00001011
410	00111000
411	00011000
412	00001100
413	01001001
414	00010110
415	00001011
416	00111001
417	00000111
420	00010000
421	00000010
422	00010201
423	00010101
424	00019010
425	00011001
426	00010111
427	00010113
430	00010011
431	00011013
432	00011011
433	00011100
434	00011001
435	00011110
436	00011111
437	00100000
440	00011101
441	00110101
442	00100101
443	00100100
444	00100001
445	00100110
446	00100110
447	00010000
450	00101001
451	00101010
452	11000111
453	00101100
454	00101100
455	00101011
456	00101111
457	00110000
460	00110001
461	00110001
462	00110000
463	00110100
464	00011001
465	00110110
466	00110111
467	00111000
470	00111001
471	00111010
472	00111011
473	00111001
474	0011.101
475	01000100
476	00111111
477	00111111
500	01000001
501	01000010
502	01000011
503	00011001
504	01000110
505	01000001
506	01000600
507	01001000
510	00000111
511	11011010
512	01001011
513	00000010
514	01001100
515	01110111
516	01001111
517	01010000
520	01010001
521	01011001
522	00000000
523	01010100
524	01013010
525	01010110
526	01010111
527	10110101
530	11011011
531	01101001
532	10110100
533	10010101
534	01011101
535	01011110
536	11001110
537	01010101
540	01100001
541	10011011
542	01100000
543	01100100
544	01100101
545	01100000
546	01101000
547	01100110
550	01101000
551	01101100
552	01101100
553	01010000
554	01101101
555	00000000
556	01101111
557	01110000
560	01110101
561	01110010
562	01110011
563	01111101
564	01110100
565	01110110
566	00000000
567	01111001
570	01111001
571	00000000
572	01111011
573	01111100
574	01111101
575	01111101
576	01111100
577	10000001
600	10000001
601	10000001
602	01001101
603	01001101
604	10000110
605	10000100
606	10000111
607	10010010
610	10010100
611	10001010
612	10001100
613	00000000
614	11110001
615	01101100
616	10001111
617	10011001
620	11010100
621	10010011
622	00000000
623	10010101
624	01010010
625	11000100
626	11003110
627	11030000
630	10010101
631	10011011
632	10100001
633	11000010
634	11001010
635	10010101
636	10100000
637	10101010
640	10100001
641	10100010
642	11101010
643	10100100
644	10100101
645	11000000
646	10100110
647	10100111
650	10101101
651	11011000
652	10101110
653	10110000
654	10111001
655	10000111
656	10101111
657	00000000
660	01101110
661	10110010
662	10110010
663	10110001
664	01100011
665	10110101
666	10110111
667	10110111
670	10110110
671	10111010
672	10111011
673	10111100
674	11003101
675	01011011
676	11101111
677	01001110
700	10111110
701	11000011
702	11000001
703	00000000
704	11002310
705	11000101
706	11001000
707	11000111
710	11001011
711	10001011
712	11001100
713	10111111
714	11001001
715	00103001
716	11001110
717	11012091
720	10100110
721	10010101
722	10010000
723	10006111
724	11010110
725	00001111
726	00000000
727	11010110
730	11009010
731	11011000
732	11100111
733	01011010
734	10110100
735	01011110
736	01100011
737	01100111
740	11100001
741	01101100
742	00000000
743	10011111
744	10011111
745	10111000
746	11100111
747	11100111
750	11101001
751	01010010
752	11101011
753	11100011
754	11101101
755	10010101
756	00000000
757	10000111
760	00000000
761	10010101
762	00000000
763	00000000
764	00000000
765	00000000
766	00000000
767	00000000
770	00000000
771	00000000
772	00000000
773	00000000
774	00000000
775	00000000
776	00000000
777	00000000

A3U16 ROM 512X8
1818–2234



NOTE

If Both I8 and $\overline{I8}$ are high the output bits are all high.

OCTAL ADD	BIT PATTERN MSB◄—►LSB
000	000000010
001	10010001
002	01001101
003	00001000
004	00000111
005	00000100
006	00100001
007	00010100
010	00111000
011	00001010
012	00001010
013	00010010
014	00010110
015	00001011
016	00111001
017	00000111
020	11010101
021	00010010
022	00010001
023	00010101
024	00010100
025	00010011
026	00010010
027	01001100
030	00011000
031	00100001
032	00111000
033	00000010
034	00011001
035	00100001
036	00111000
037	00000010
040	00011001
041	00110101
042	01001010
043	00100100
044	00100001
045	00100110
046	11001101
047	00101000
050	00101001
051	00101010
052	00101000
053	00101100
054	00100100
055	00101011
056	00101111
057	00110000
060	00110001
061	00100100
062	00110000
063	00110100
064	00110011
065	00110110
066	00110101
067	00111000
070	00111001
071	00111010
072	01001010
073	00111100
074	00111101
075	00111110
076	01001010
077	01001100
100	00111110
101	01000010
102	01000001
103	00100001
104	01001010
105	01000100
106	11100110
107	01001000
110	00000111
111	11011010
112	01001011
113	01001010
114	00111001
115	01001110
116	01001111
117	01010000
120	01010001
121	01001101
122	01010011
123	01010100
124	10000010
125	01010110
126	01010111
127	01010101
130	11011011
131	01101001
132	10110100
133	10010101
134	01011101
135	01011110
136	01011100
137	01010101
140	01100001
141	01101110
142	01100000
143	01100100
144	01100101
145	01100000
146	01101000
147	01100110
150	01101110
151	01101010
152	01101100
153	01010000
154	11100000
155	01101100
156	01101111
157	01110000
160	01101110
161	01110010
162	01110001
163	01110100
164	01101011
165	01110110
166	01110101
167	01111000
170	01111001
171	00000000
172	01111111
173	01111110
174	01001101
175	01010010
176	01111100
177	10000000
200	10000001
201	01010010
202	10000011
203	01001101
204	10000110
205	10000100
206	10000111
207	10001000
210	10010100
211	10001010
212	10001010
213	10001101
214	11110001
215	01101100
216	10001111
217	10011001
220	11010100
221	10010011
222	10010010
223	10010101
224	10010100
225	10010110
226	11000110
227	10011000
230	10010101
231	10011011
232	10100001
233	10011100
234	11001010
235	10011001
236	10011110
237	10101010
240	10100001
241	10100010
242	11101010
243	10100100
244	10105011
245	10100111
246	10101001
247	10010101
250	10101101
251	10101001
252	10101011
253	10110000
254	10011111
255	10101000
256	10101111
257	10101110
260	01101110
261	10110010
262	10101010
263	10110001
264	01100011
265	01010005
266	10110111
267	10101010
270	10110110
271	10111010
272	10111011
273	10111100
274	10111010
275	10011001
276	11101111
277	01001110
300	11000000
301	11000011
302	11000001
303	00000000
304	11000100
305	10111101
306	11000110
307	00100001
310	11001011
311	11100000
312	11001100
313	10111111
314	11001001
315	00100001
316	01010100
317	11010001
320	10100110
321	10010101
322	10010000
323	10000111
324	11010100
325	11010101
326	11010111
327	11010011
330	11011001
331	11001111
332	11011010
333	01011010
334	01011010
335	11011110
336	01100011
337	01100111
340	11100001
341	11100010
342	11100000
343	10011111
344	10011111
345	10111000
346	11100111
347	00111001
350	11101001
351	01010010
352	11100011
353	11100011
354	11101101
355	10010101
356	00000000
357	10000111
360	00000000
361	10010101
362	00000000
363	00000000
364	00000000
365	00000000
366	00000000
367	00000000
370	00000000
371	00000000
372	00000000
373	00000000
374	00000000
375	00000000
376	00000000
377	00000000
400	00000011
401	10000101
402	00000001
403	00000101
404	00000111
405	00000100
406	00011001
407	00001001
410	00111000
411	00000111
412	00001110
413	00010010
414	00010110
415	00001011
416	00111001
417	00000111
420	11010101
421	00000010
422	00010001
423	00010101
424	00010010
425	00011001
426	00010010
427	00010110
430	00010011
431	00011010
432	00000101
433	00011100
434	00011001
435	00011110
436	00000101
437	00100000
440	00011101
441	00110101
442	01001010
443	00101101
444	00110011
445	00100110
446	11001101
447	00101000
450	00101001
451	00101010
452	11000111
453	00101100
454	00101100
455	00101011
456	00101111
457	00110000
460	00110001
461	00110001
462	00110000
463	00110100
464	00011001
465	00110110
466	00110111
467	00000101
470	00111001
471	01000111
472	01001010
473	00111001
474	00111101
475	01000100
476	01001010
477	01000000
500	00111110
501	01000010
502	01000011
503	00011001
504	01001010
505	01000100
506	01000000
507	01001000
510	00000111
511	00010000
512	01001011
513	00000010
514	01001100
515	01110111
516	00000010
517	01010000
520	01011000
521	01111010
522	00000000
523	01010100
524	01010010
525	01010110
526	01010111
527	00110101
530	01010001
531	01101001
532	10110100
533	10010101
534	01011101
535	01011110
536	11001110
537	01010101
540	01100001
541	01100001
542	01100000
543	01100100
544	01100101
545	01100000
546	01101000
547	01100110
550	01101000
551	01101100
552	01101100
553	01010000
554	01101101
555	01111101
556	01110000
557	01100011
560	01110001
561	01110010
562	01110011
563	01111101
564	01110100
565	01110110
566	00000000
567	01111001
570	01111001
571	00000000
572	01111111
573	01111100
574	01111101
575	01111101
576	01111100
577	10000001
600	10000001
601	10000001
602	01001101
603	01001101
604	10000110
605	10000100
606	10000111
607	10010010
610	10001001
611	10000111
612	10001100
613	11010010
614	11110001
615	10001110
616	10001011
617	10011001
620	10010000
621	10010011
622	00000000
623	10010101
624	01001101
625	11000100
626	10010111
627	11000000
630	10011110
631	10011010
632	10100001
633	11010000
634	10011101
635	11001010
636	10100000
637	10110011
640	10100001
641	10100010
642	11101010
643	10100100
644	10100101
645	10100111
646	10100110
647	10100111
650	10101101
651	11011000
652	10100011
653	10101100
654	10101000
655	10000111
656	10101111
657	00000000
660	01101110
661	10110010
662	10110010
663	10110001
664	01100011
665	01010000
666	10110111
667	10110111
670	10110110
671	10111010
672	10111011
673	10111100
674	11000101
675	01011011
676	11101111
677	01001110
700	10111110
701	11000011
702	11000001
703	00000000
704	11000010
705	10111101
706	11001000
707	00100001
710	11001011
711	10001011
712	11001100
713	10111111
714	11001001
715	00100001
716	01010100
717	11010001
720	10100110
721	10010101
722	10010000
723	10000111
724	11010110
725	00001111
726	00000000
727	11010110
730	11000010
731	11011000
732	11100111
733	01011010
734	10110100
735	11011110
736	01100011
737	01100111
740	10110100
741	01101100
742	01111101
743	10011111
744	10011111
745	10111000
746	11100111
747	00111001
750	11101001
751	01010010
752	11101011
753	11100011
754	11101101
755	10010101
756	00000000
757	10000111
760	00000000
761	10010101
762	00000000
763	00000000
764	00000000
765	00000000
766	00000000
767	00000000
770	00000000
771	00000000
772	00000000
773	00000000
774	00000000
775	00000000
776	00000000
777	00000000

OCTAL ADD	BIT PATTERN MSB ⟷ LSB
000	00111001
001	00101001
002	00101001
003	00110001
004	10110011
005	00110001
006	00110001
007	00110111
010	00110001
011	00110111
012	00110111
013	00110111
014	11110110
015	00110111
016	00110111
017	00110111
020	00110111
021	00101101
022	10101101
023	10110101
024	00100111
025	00110101
026	11110101
027	11110101
030	00110111
031	00110101
032	00110101
033	00110101
034	00110101
035	01110101
036	01110101
037	01110101
040	01110101
041	00110101
042	00110101
043	00110101
044	00110101
045	00110101
046	00110101
047	00110101
050	00110101
051	10110101
052	00110101
053	00110100
054	00110101
055	10110101
056	00110101
057	10110101
060	00110100
061	00110101
062	10110101
063	10110101
064	00110101
065	10110101
066	00110101
067	00110101
070	10110101

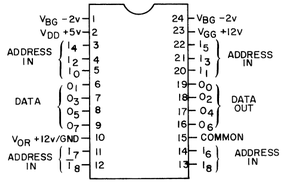
OCTAL ADD	BIT PATTERN MSB ⟷ LSB
071	00110101
072	00110101
073	00110101
074	01110100
075	01110101
076	01110101
077	01110101
100	01110101
101	10110101
102	00110101
103	00110101
104	01110101
105	01110101
106	01110101
107	00110001
110	00110011
111	00110111
112	10101101
113	00101101
114	11110101
115	00101101
116	00101101
117	00101101
120	00101101
121	00101101
122	00011101
123	00011101
124	00011101
125	00101101
126	10101101
127	00101101
130	00101101
131	00101101
132	10101101
133	00111111
134	00011101
135	10011101
136	00011101
137	00101101
140	00101100
141	00101101
142	10101101
143	00101101
144	00101101
145	10101101
146	00101100
147	10101101
150	00101101
151	00101101
152	00101101
153	10101101
154	00101101
155	00101101
156	00101101
157	00101101
160	00101101
161	10101101

OCTAL ADD	BIT PATTERN MSB ⟷ LSB
162	00101101
163	00101101
164	00101101
165	10111101
166	00111101
167	00101101
170	10101101
171	00101101
172	00101101
173	00101101
174	00101101
175	00011101
176	00101101
177	00101100
200	00101101
201	00101101
202	00011101
203	10011101
204	00101001
205	00101001
206	00101101
207	00111111
210	00111111
211	00111111
212	00111111
213	00111111
214	00111111
215	00111111
216	00111111
217	00111111
220	00011111
221	00101001
222	00111111
223	00101011
224	00111111
225	00111111
226	00111111
227	00111111
230	00111111
231	00111111
232	00001111
233	00111111
234	00111111
235	00111111
236	00111111
237	00111111
240	00111111
241	00111111
242	10111111
243	10111111
244	00111111
245	00111111
246	00011101
247	00111111
250	10111111
251	00011101
252	00111111

OCTAL ADD	BIT PATTERN MSB ⟷ LSB
253	00111111
254	00111111
255	00111111
256	10111111
257	00111111
260	00111111
261	00111110
262	00111111
263	10111111
264	00101101
265	00101101
266	00111110
267	00111111
270	10111111
271	00111111
272	00111111
273	10111111
274	00111111
275	00111111
276	00111111
277	10101101
300	00111111
301	10111101
302	00111101
303	00111101
304	00111111
305	00111111
306	00111111
307	00110101
310	00101101
311	10111111
312	00111111
313	00101101
314	00111111
315	10110101
316	00011101
317	00011111
320	00111101
321	00011111
322	00111111
323	00011111
324	00011111
325	00110111
326	00011111
327	00011111
330	00011111
331	00011111
332	11110101
333	00101101
334	00101101
335	00101101
336	10101101
337	00101101
340	00101101
341	00101101
342	00101101
343	00111111

OCTAL ADD	BIT PATTERN MSB ⟷ LSB
344	10111111
345	00111111
346	11110101
347	00110101
350	00011101
351	10011101
352	00111111
353	00111111
354	00111111
355	00111111
356	00111101
357	00111111
360	00111101
361	00111111
362	00111101
363	00111101
364	00111101
365	00111101
366	00111101
367	00111101
370	00111101
371	00111101
372	00111101
373	00111101
374	00111101
375	00111101
376	00111101
377	00111101
400	11111111
•	
•	
•	
776	11111111
777	11111111

A3U26 ROM 512X8
1818–2235

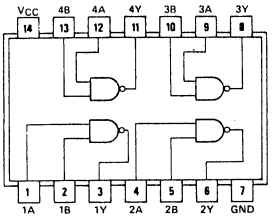


NOTE

If Both I8 and $\overline{I8}$ are high the output bits are all high.

9

A1U204, 413
A3U7, 35, 202, 203
SN7400N

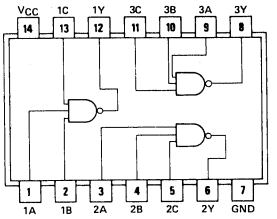


Quad 2 Input Nand Gates

10

A3U8

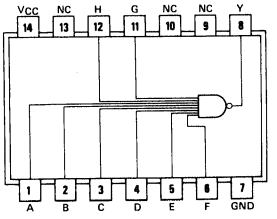
SN7410N
1820–0068



Triple 3–Input
Positive Nand Gates

11

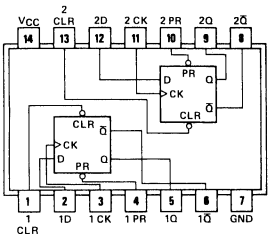
A1U211
SN7430N



8 Input Nand Gates

12

A3U17, 18, 110
SN7474



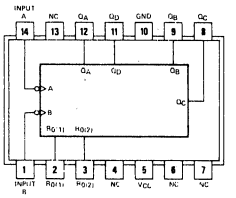
Dual D Flip Flops

FUNCTION TABLE

INPUTS				OUTPUTS	
PRESET	CLEAR	CLOCK	D	Q	$\bar{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\bar{Q}_0$

13

A3U109
SN7493

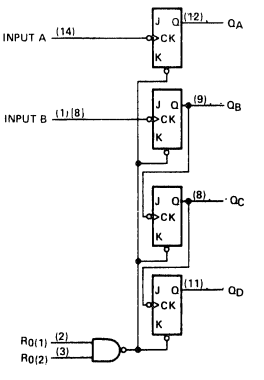


4–Bit Binary Up Counter

'93A,
COUNT SEQUENCE

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

('93A)



93A
RESET/COUNT FUNCTION TABLE

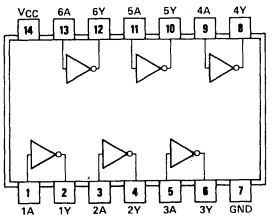
RESET INPUTS		OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

14

A3U116

SN7405N
1820–0175

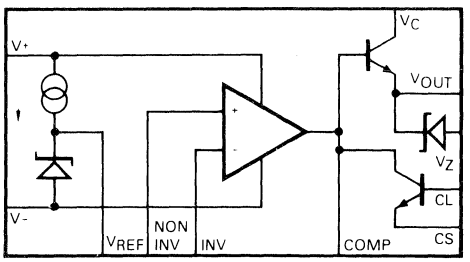
Δ1a Used on serial numbers 1714A00490 and below only.



Hex Inverters
With Open Collector Outputs

15

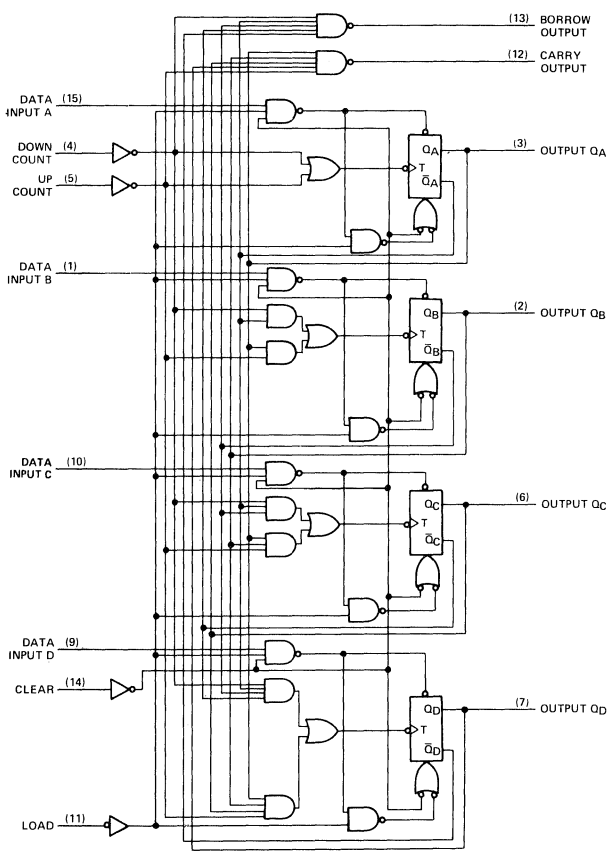
A1U1
723 HC
1820–0196



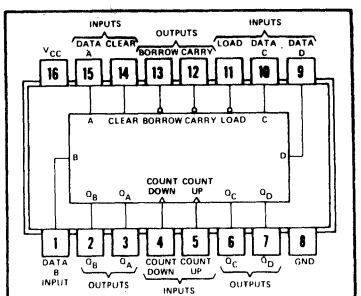
Voltage Regulator

16

'193



A1U203, 205
SN74193N
1820–0233

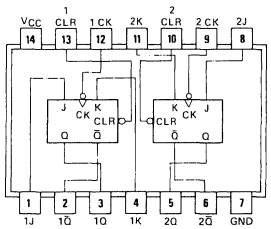


logic: Low input to load sets Q_A = A, Q_B = B, Q_C = C, and Q_D = D

17

A1U212

SN74107N
1820–0281



DUAL J-K MASTER-SLAVE FLIP-FLOPS WITH CLEAR

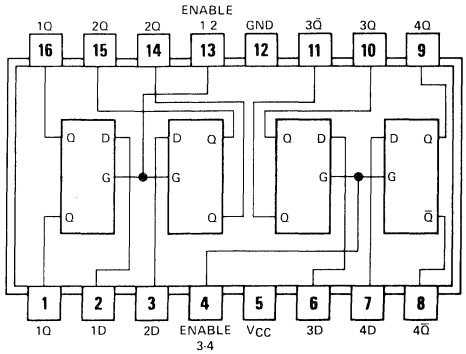
FUNCTION TABLE

INPUTS				OUTPUTS	
CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	X	X	X	L	H
H	⎍	L	L	Q_0	$\bar{Q}_0$
H	⎍	H	L	H	L
H	⎍	L	H	L	H
H	⎍	H	H	TOGGLE	

18

A1U214
A3U5, 6, 21, 27–30

SN7475N



Quad D Flip Flop

FUNCTION TABLE
(Each Latch)

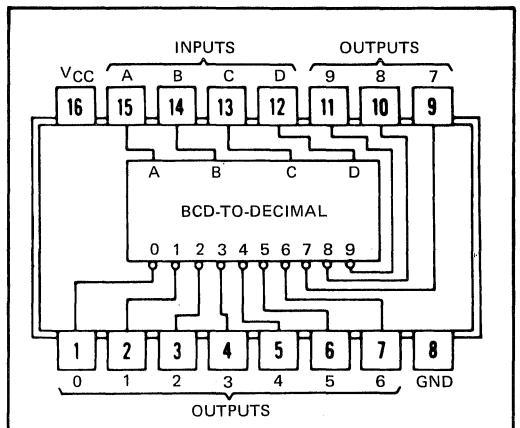
INPUTS		OUTPUTS	
D	G	Q	$\bar{Q}$
L	H	L	H
H	H	H	L
X	L	Q_0	$\bar{Q}_0$

H = high level, L = low level, X = irrelevant
Q_0 = the level of Q before the high-to-low transition of G

19

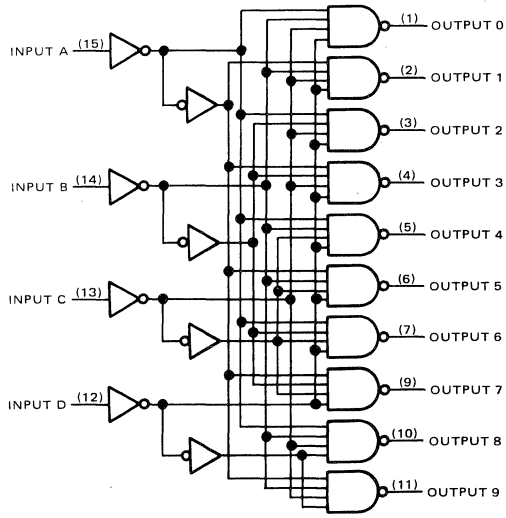
A3U105
SN74145
1820–0491

Δ_{1a} Used on serial numbers 1714A00490 and below only.



positive logic: see function table

functional block diagram

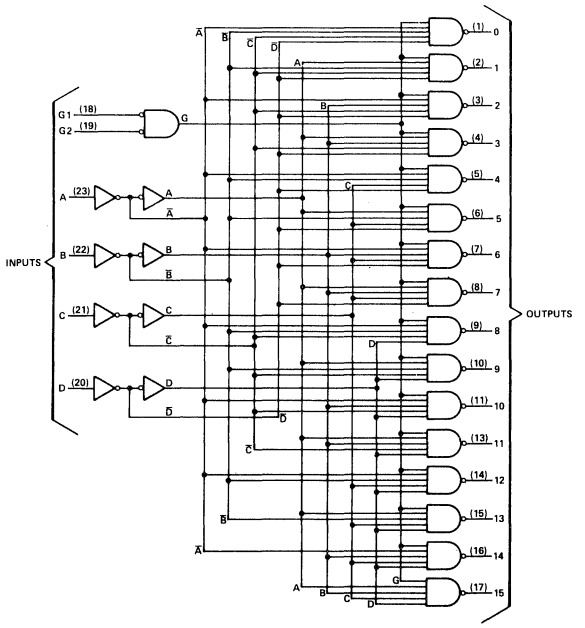


NO.	INPUTS				OUTPUTS									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	H	L	H	H	H	H	H	H	H	H
2	L	L	H	L	H	H	L	H	H	H	H	H	H	H
3	L	L	H	H	H	H	H	L	H	H	H	H	H	H
4	L	H	L	L	H	H	H	H	L	H	H	H	H	H
5	L	H	L	H	H	H	H	H	H	L	H	H	H	H
6	L	H	H	L	H	H	H	H	H	H	L	H	H	H
7	L	H	H	H	H	H	H	H	H	H	H	L	H	H
8	H	L	L	L	H	H	H	H	H	H	H	H	L	H
9	H	L	L	H	H	H	H	H	H	H	H	H	H	L
INVALID	H	L	H	L	H	H	H	H	H	H	H	H	H	H
	H	L	H	H	H	H	H	H	H	H	H	H	H	H
	H	H	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	H	L	H	H	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H	H	H	H	H	H	H

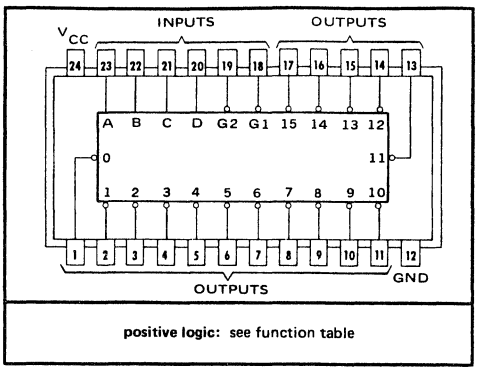
H = high level (off), L = low level (on)

functional block diagram and schematics of inputs and outputs

20



A2U5, 9
SN74154N
1820–0495



positive logic: see function table

FUNCTION TABLE

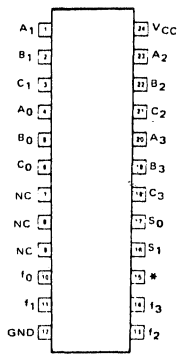
INPUTS						OUTPUTS													
G1	G2	D	C	B	A	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
L	L	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
L	L	H	H	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = high level, L = low level, X = irrelevant

21

A3U1
N8263B
1820–0506

8263
N,F,Q PACKAGE



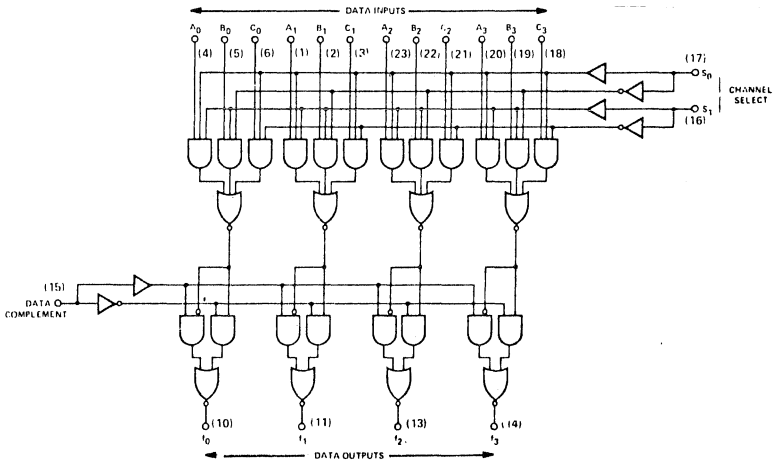
TRUTH TABLE

DATA INPUT A_n	B_n	C_n	CHANNEL SELECT S_0	S_1	DATA COMPLEMENT	OUTPUT ENABLE (8264)	DATA OUTPUTS
A_n	x	x	1	1	0	1	A_n
x	B_n	x	0	1	0	1	B_n
x	x	C_n	1	0	0	1	C_n
x	x	x	0	0	0	1	0
A_n	x	x	1	1	1	1	$\overline{A}_n$
x	B_n	x	0	1	1	1	$\overline{B}_n$
x	x	C_n	1	0	1	1	$\overline{C}_n$
x	x	x	0	0	1	1	1
x	x	x	x	x	x	0	1

X either state

LOGIC DIAGRAM

8263 (ACTIVE PULL-UP)



V_{CC} (24)
GND (12)
( ) denotes pin numbers

DESCRIPTION

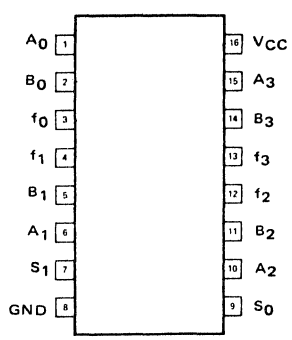
The 8263/8264 3-Input, 4-Bit Multiplexer is a gating array whose function is analogous to that of a 4-pole, 3-position switch. Four bits of digital data are selected from one of three inputs. A 2-bit channel-selection code determines which input is to be active.

The Data Complement input controls the conditional complement circuit at the Multiplexer output to effect either inverting or non-inverting data flow.

22

A1U107–109, 301–303, 414, 418, 421
A3U103, 104
N8266B
1820–0507

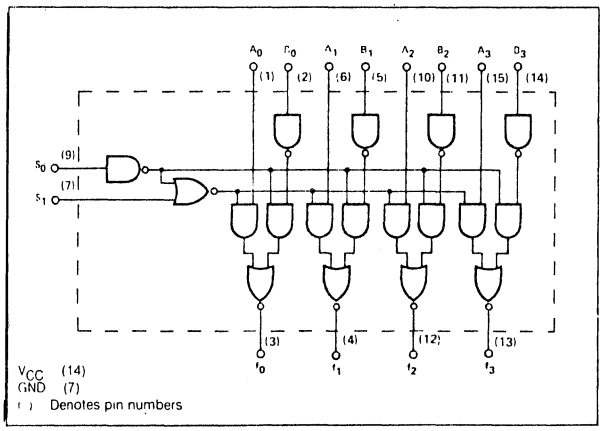
B,F,W PACKAGE



TRUTH TABLE

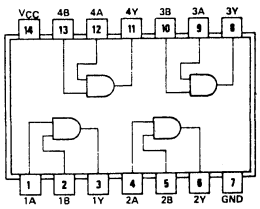
SELECT LINES S_0	S_1	OUTPUTS f_n (0, 1, 2, 3)
0	0	B_n
0	1	B_n
1	0	$\overline{A}_n$
1	1	1

LOGIC DIAGRAM



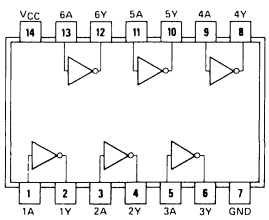
V_{CC} (14)
GND (7)
( ) Denotes pin numbers

A3U9
SN7408N
1820–0511

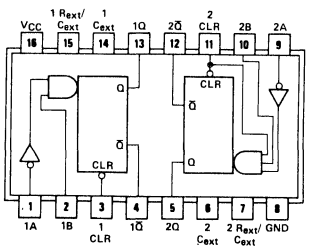


Quadruple 2-Input
Positive and Gates

A1U209, 304
A3U111 Δ1a, 201
SN7416N
1820–0577



A1U201
A3U12
SN74123N
1820–0579

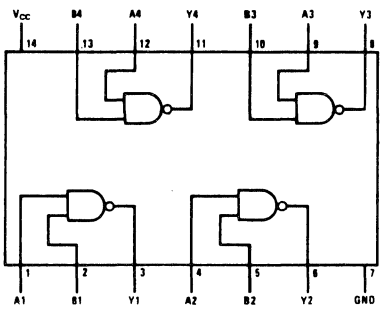


DUAL RETRIGGERABLE MONOSTABLE MULTIVIBRATORS WITH CLEAR

FUNCTION TABLE

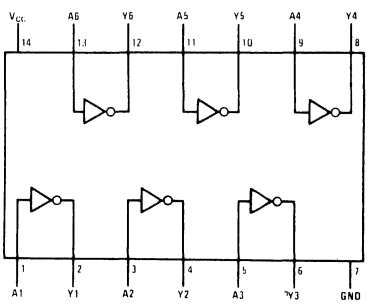
INPUTS			OUTPUTS	
CLEAR	A	B	Q	Q̄
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↑	⎍	⎎
H	↓	H	⎍	⎎
↑	L	H	⎍	⎎

A1U103, 401–411, 416, 420
DM74L00
1820–0583



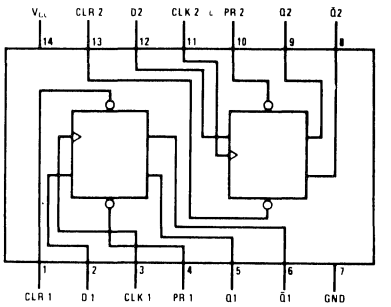
Quad 2-Input NAND Gates

A3U31–34, 107 Δ1a, 117 Δ1a
DM74L04N
1820–0586



Hex Inverter

A3U19, 20
DM74L74N
1820–0596



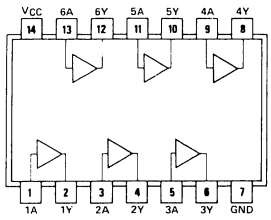
TRUTH TABLE

INPUTS				OUTPUTS	
PR	CLR	CLK	D	Q	Q̄
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q0	Q̄0

Δ1a Used on serial numbers 7414A00490 and below only.

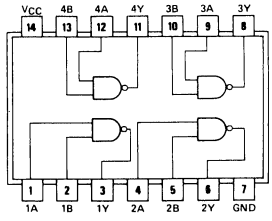
29

A1U104, 105 Δ1a, 210
A3U115
SN7417N
1820–0618



31

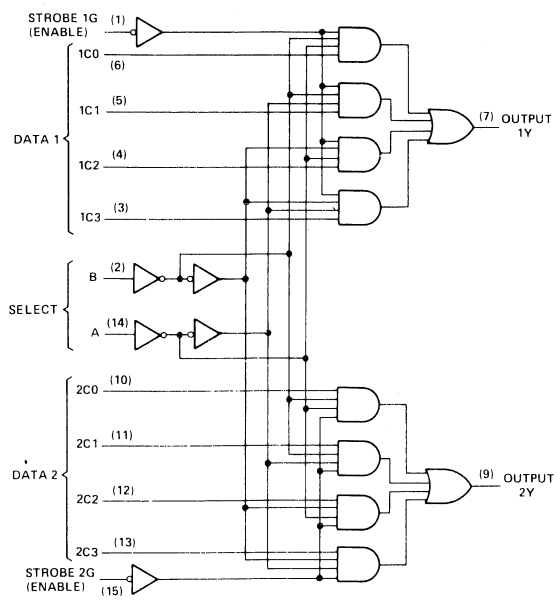
A1U101, 110
A3U22
SN7438N
1820–0621

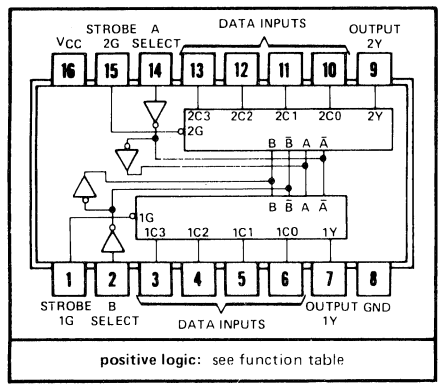


Δ1a Used on serial numbers 1714A00490 and below only.

30

A3U101, 102
SN74153
1820–0620





positive logic: see function table

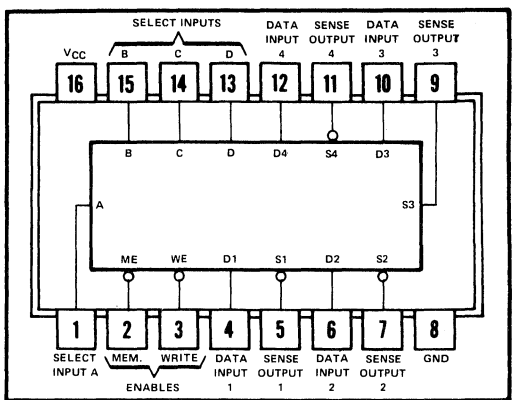
FUNCTION TABLE

SELECT INPUTS		DATA INPUTS				STROBE	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Select inputs A and B are common to both sections.
H = high level, L = low level, X = irrelevant

32

A1U206–208, 215–217
SN7489N
1820–0628

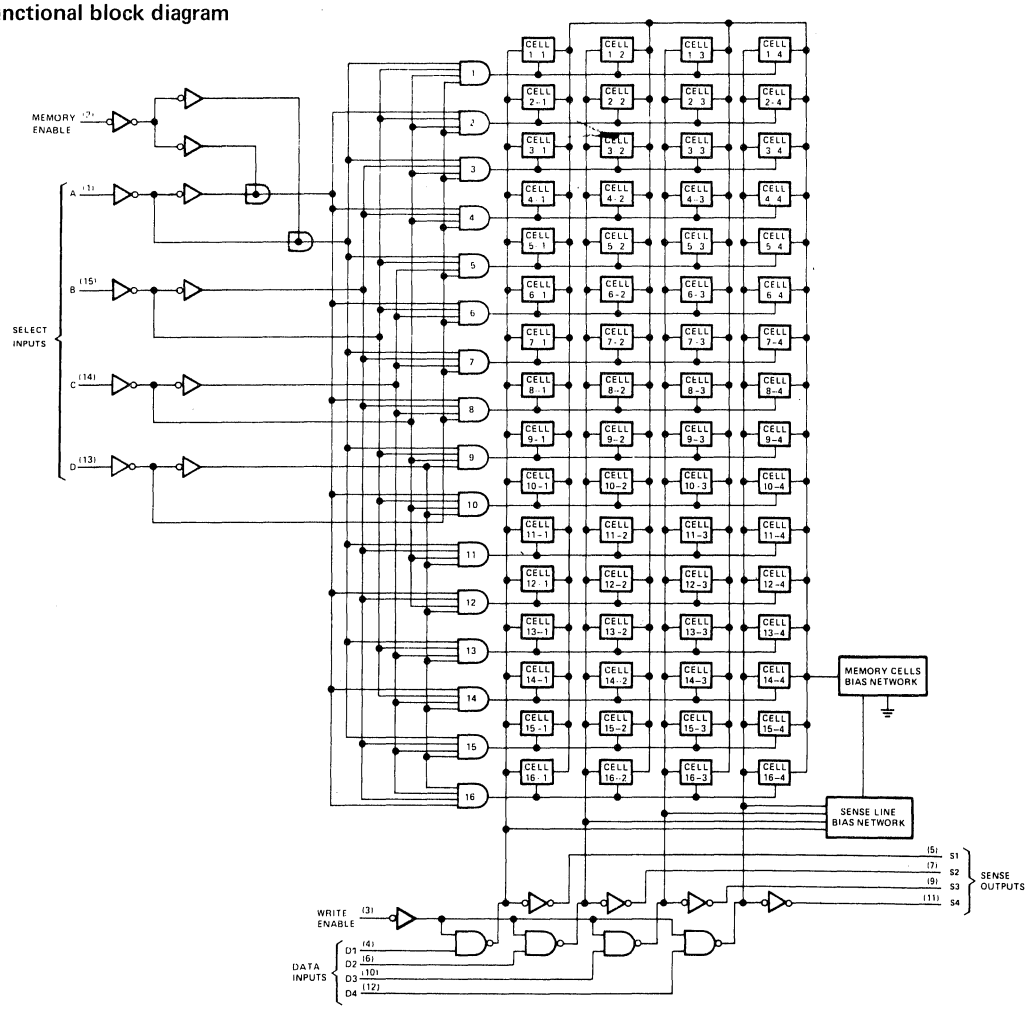


†Pin assignments for these circuits are the same for all packages.

FUNCTION TABLE

ME	WE	OPERATION	CONDITION OF OUTPUTS
L	L	Write	Complement of Data Inputs
L	H	Read	Complement of Selected Word
H	L	Inhibit Storage	Complement of Data Inputs
H	H	Do Nothing	High

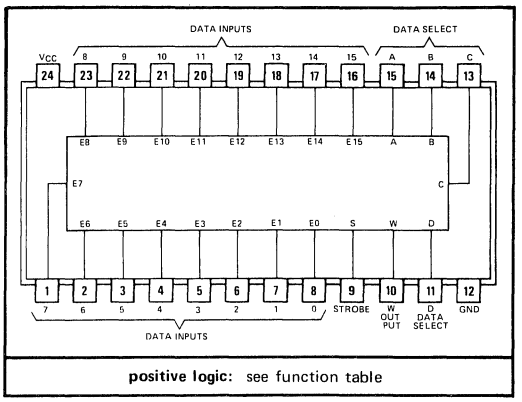
functional block diagram



33

A3U13, 14
SN74150N
1820–0640

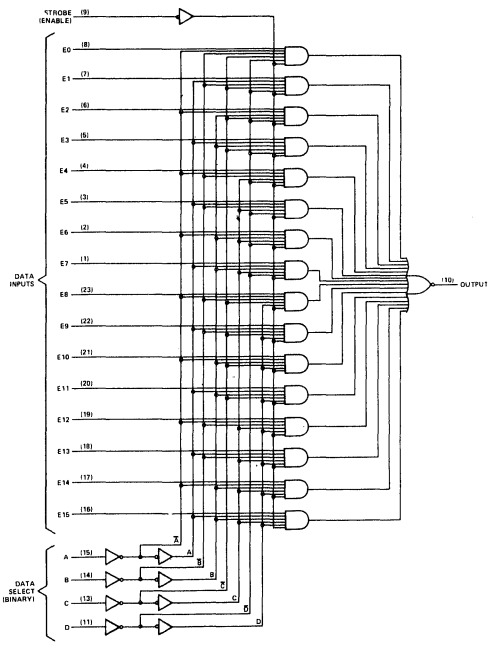
One–Of–16–Data–Selector



positive logic: see function table

functional block diagrams

'150



logic

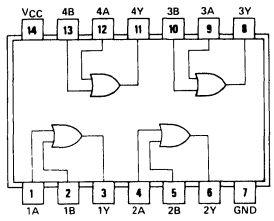
'150

FUNCTION TABLE

INPUTS					OUTPUT
SELECT				STROBE	
D	C	B	A	S	W
X	X	X	X	H	H
L	L	L	L	L	$\overline{E0}$
L	L	L	H	L	$\overline{E1}$
L	L	H	L	L	$\overline{E2}$
L	L	H	H	L	$\overline{E3}$
L	H	L	L	L	$\overline{E4}$
L	H	L	H	L	$\overline{E5}$
L	H	H	L	L	$\overline{E6}$
L	H	H	H	L	$\overline{E7}$
H	L	L	L	L	$\overline{E8}$
H	L	L	H	L	$\overline{E9}$
H	L	H	L	L	$\overline{E10}$
H	L	H	H	L	$\overline{E11}$
H	H	L	L	L	$\overline{E12}$
H	H	L	H	L	$\overline{E13}$
H	H	H	L	L	$\overline{E14}$
H	H	H	H	L	$\overline{E15}$

34

A1U213
A3U10, 114
SN7432N
1820–0661



35

A1U412
9324DC
1820–0706

36

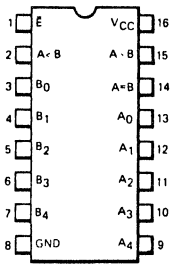
A1U415, 419
93L24DC
1820–0904

TRUTH TABLE

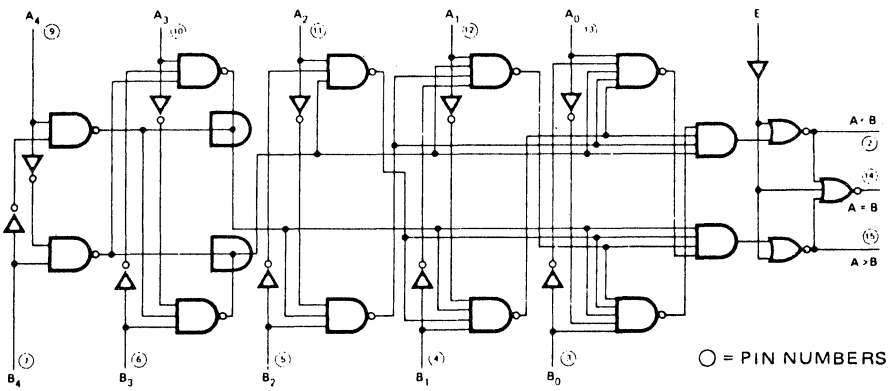
$\bar{E}$	Ay By	A < B	A > B	A = B
H	X X	L	L	L
L	Word A = Word B	L	L	H
L	Word A > Word B	L	H	L
L	Word B > Word A	H	L	L

H = HIGH Voltage Level
L = LOW Voltage Level
X = Either HIGH or LOW Voltage Level

CONNECTION DIAGRAMS
DIP (TOP VIEW)

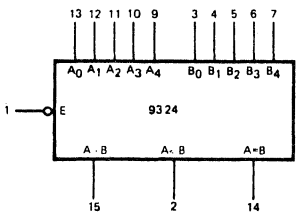


LOGIC DIAGRAM



○ = PIN NUMBERS

LOGIC SYMBOL



V_{CC} = Pin 16
GND = Pin 8

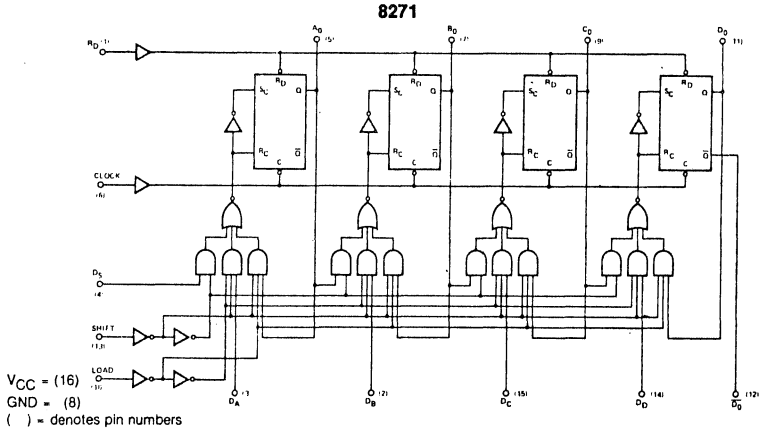
37

A3U23, 24
SN8271
1820–0989

TRUTH TABLE

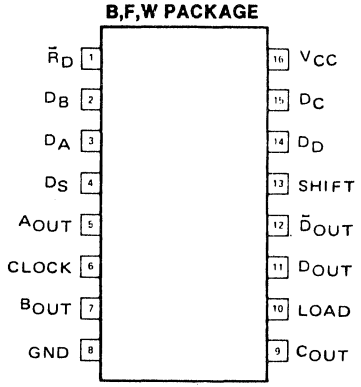
CONTROL STATE	LOAD	SHIFT
Hold	0	0
Parallel Entry	1	0
Shift Right	0	1
Shift Right	1	1

8271



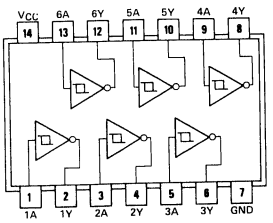
V_{CC} = (16)
GND = (8)
( ) = denotes pin numbers

8271
B,F,W PACKAGE



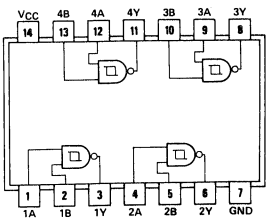
38

A1U106
A3U113, 201
SN7414
1820–1053



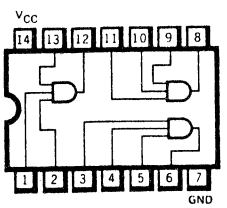
39

A1U102
SN74132
1820–1056



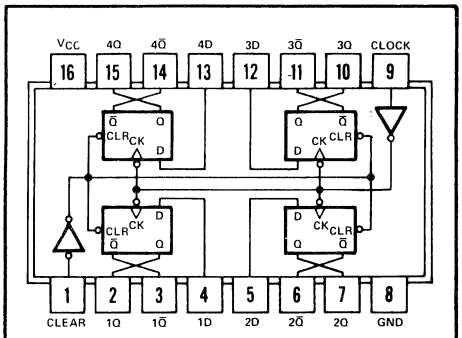
40

A3U112
7411PC
1820–1066



41

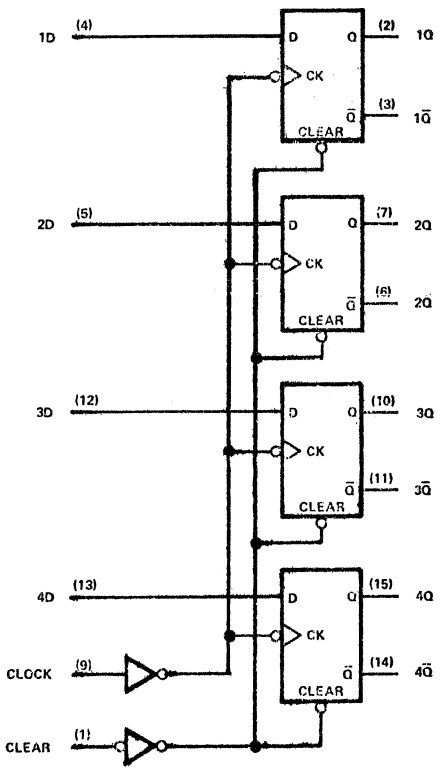
A3U2, 11
SN74S175N
1820–1141



positive logic: see function table

FUNCTION TABLE
(EACH FLIP-FLOP)

INPUTS			OUTPUTS	
CLEAR	CLOCK	D	Q	Q̄†
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	Q_0	$\bar{Q}_0$



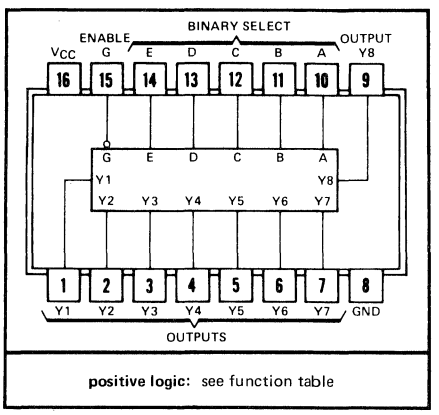
42

A1U202
1820-1191
SN74185

FUNCTION TABLE

BINARY WORDS	INPUTS						OUTPUTS							
	BINARY SELECT					ENABLE								
	E	D	C	B	A	G	Y8	Y7	Y6	Y5	Y4	Y3	Y2	Y1
0 1	L	L	L	L	L	L	H	H	L	L	L	L	L	L
2 3	L	L	L	L	H	L	H	H	L	L	L	L	L	H
4 5	L	L	L	H	L	L	H	H	L	L	L	L	H	L
6 7	L	L	L	H	H	L	H	H	L	L	L	L	H	H
8 9	L	L	H	L	L	L	H	H	L	L	L	H	L	L
10 11	L	L	H	L	H	L	H	H	L	L	L	H	L	L
12 13	L	L	H	H	L	L	H	H	L	L	H	L	L	H
14 15	L	L	H	H	H	L	H	H	L	L	H	L	H	L
16 17	L	H	L	L	L	L	H	H	L	L	H	L	H	H
18 19	L	H	L	L	H	L	H	H	L	L	H	H	L	L
20 21	L	H	L	H	L	L	H	H	L	H	L	L	I	L
22 23	L	H	L	H	H	L	H	H	L	H	L	L	L	H
24 25	L	H	H	L	L	L	H	H	L	H	L	L	H	L
26 27	L	H	H	L	H	L	H	H	L	H	L	L	H	H
28 29	L	H	H	H	L	L	H	H	L	H	L	H	L	L
30 31	L	H	H	H	H	L	H	H	L	H	H	L	L	L
32 33	H	L	L	L	L	L	H	H	L	H	H	L	L	H
34 35	H	L	L	L	H	L	H	H	L	H	H	L	H	L
36 37	H	L	L	H	L	L	H	H	L	H	H	L	H	H
38 39	H	L	L	H	H	L	H	H	L	H	H	H	L	L
40 41	H	L	H	L	L	L	H	H	H	I	L	L	L	L
42 43	H	L	H	L	H	L	H	H	L	H	H	L	L	H
44 45	H	L	H	H	L	L	H	H	H	L	L	L	H	L
46 47	H	L	H	H	H	L	H	H	H	L	L	L	H	H
48 49	H	H	L	L	L	L	H	H	H	L	L	H	L	L
50 51	H	H	L	L	H	L	H	H	H	L	H	L	L	L
52 53	H	H	L	H	L	L	H	H	H	L	H	L	L	H
54 55	H	H	L	H	H	L	H	H	H	L	H	L	H	L
56 57	H	H	H	L	L	L	H	H	H	L	H	L	H	H
58 59	H	H	H	L	H	L	H	H	H	I	H	H	L	L
60 61	H	H	H	H	L	L	H	H	H	H	L	L	L	L
62 63	H	H	H	H	H	L	H	H	H	H	L	L	L	H
ALL	X	X	X	X	X	H	H	H	H	H	H	H	H	H

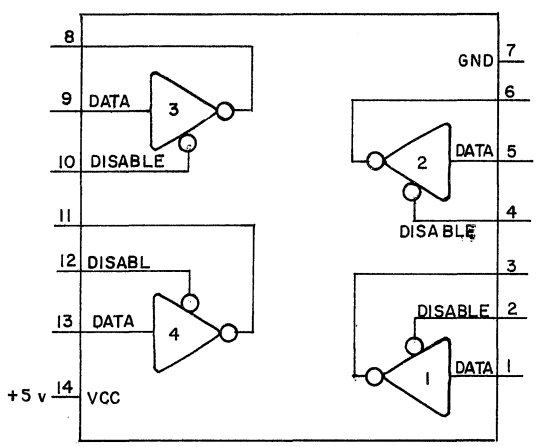
H high level, L low level, X irrelevant



positive logic: see function table

43

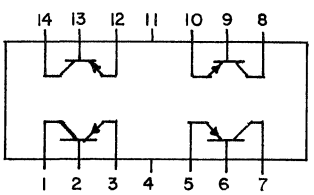
A1U111–113
Quad Tri–State Driver
1820–1335



DATA	DISABLE	OUTPUT
0	0	1
1	0	0
0	1	HI–Z
1	1	HI–Z

44

A2U1–4, 6–8
Quad PNP
1858–0014



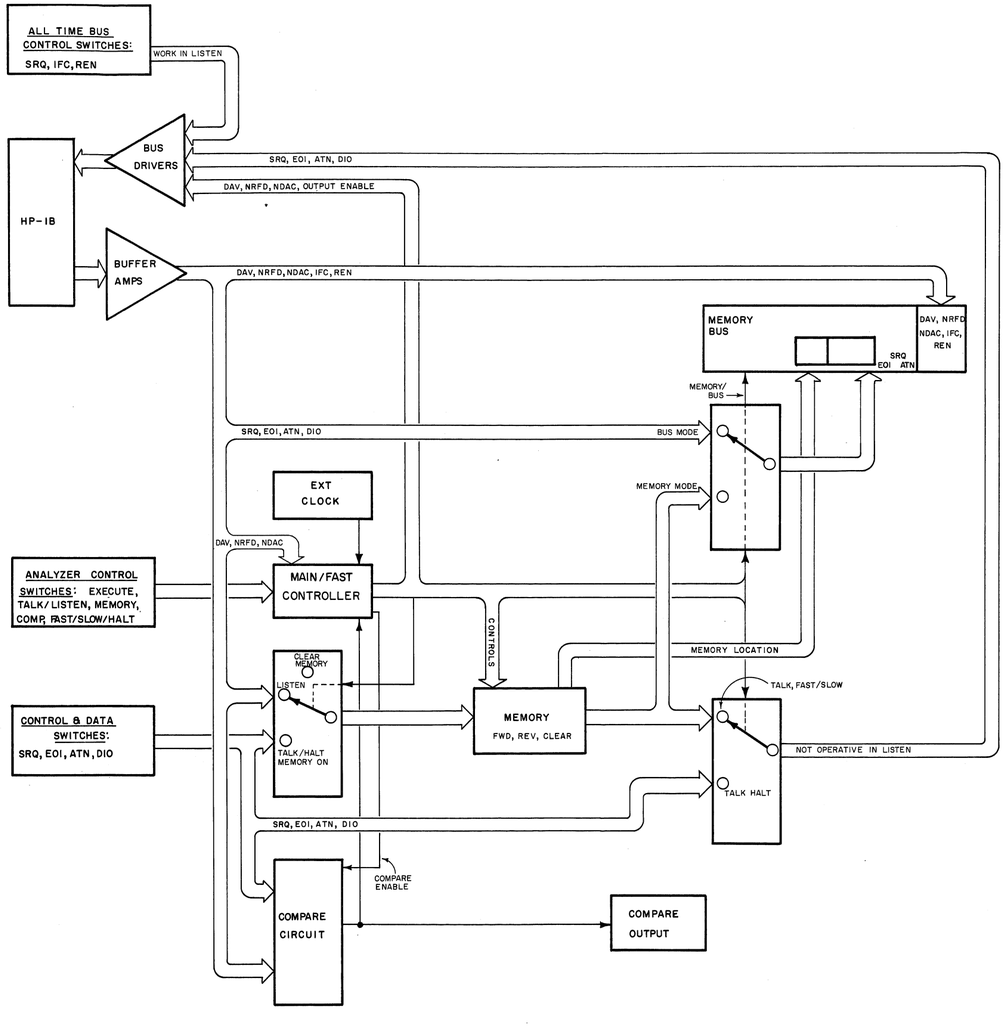


Figure 7-1. Block Diagram, 59401A.

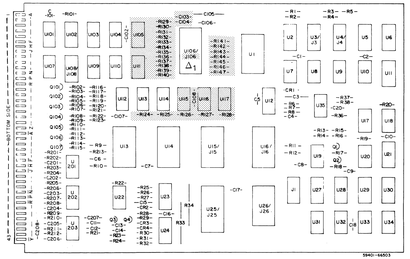
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected		
LRSL, LRFS	RUN SLOW selected	HMIS, HMIE	Applies All 1's to Memory Input (Disable)
HCMP	COMPARE switch on	HDSM	Unblanks Memory Location Digits
LTCM	COMPARE switch on and comparison is true	$LCLK_2$	Clocks Memory Location Counters
HCNT	STEP MEMORY counter reads 30	$HDVO_2$	Drives LDAV True
HDVI	LDAV is true	$HRFO_2$	Drives HRFD False
HRFI	LNRFD is false (RFD is Low)	$LDAO_2$	Drives HDAC False
HDAI	LNDAC is false (DAC is Low)	LMTB	Select Memory to Drive Bus
HMEO	MEMORY off	LCND	Counts Memory in Reverse (Down)
LMEO, LCLR	MEMORY on	HCO1	Clock F1
HOOA	SIGNAL A from fast controller	HCO2	Clock F2
HOOB	SIGNAL B from fast controller	HCO3	Clock F3
HOOC	SIGNAL C from fast controller	LRST	Reset Fast Machine
HDEL	.5 sec DELAY	LSTA	Select Talk Operationg for Fast Controller
LEMY	STEP MEMORY counter reads 31	HENF	Enable Fast Controller Output
		LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False }
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



A3
-hp- Part No. 59401-66503

Revisions A & B Boards.

Δ_1: Shaded area components do not exist on Rev. B Boards; U106 is different between Rev. A & B Boards.

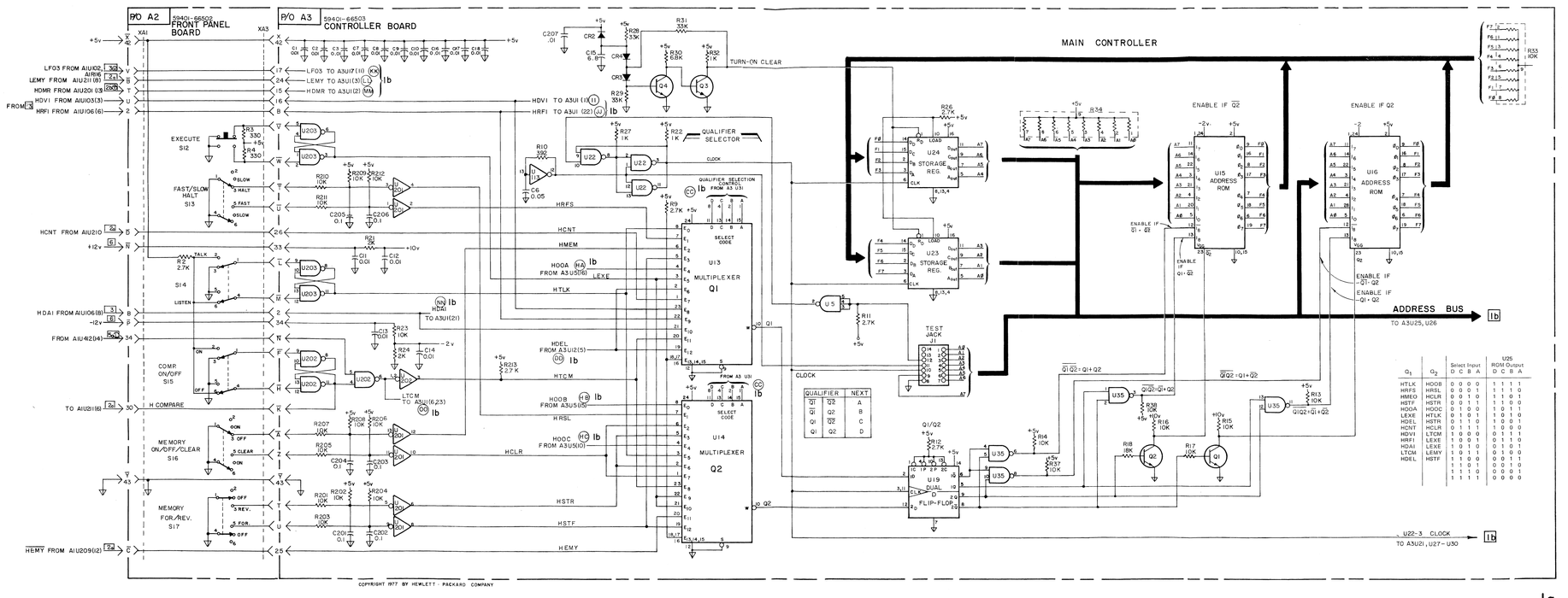


Figure 7-2. Controller, A3: Main Controller, Function Select, Address Bus.

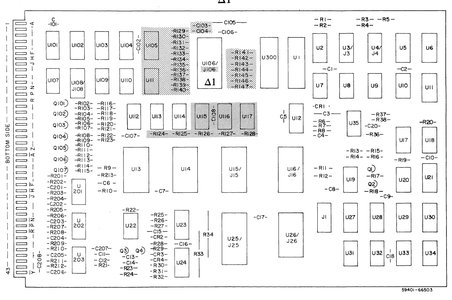
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected		
LRSL, LRFS	RUN SLOW selected	HMIS, HMIE	Applies All 1's to Memory Input (Disable)
HCMP	COMPARE switch on	HDSM	Unblanks Memory Location Digits
LTCM	COMPARE switch on and comparison is true	$LCLK_2$	Clocks Memory Location Counters
HCNT	STEP MEMORY counter reads 30	$HDVO_2$	Drives LDAV True
HDVI	LDAV is true	$HRFO_2$	Drives HRFD False
HRFI	LNRFD is false (RFD is Low)	$LDAO_2$	Drives HDAC False
HDAI	LNDAC is false (DAC is Low)	LMTB	Select Memory to Drive Bus
HMEO	MEMORY off	LCND	Counts Memory in Reverse (Down)
LMEO, LCLR	MEMORY on	HCO1	Clock F1
HOOA	SIGNAL A from fast controller	HCO2	Clock F2
HOOB	SIGNAL B from fast controller	HCO3	Clock F3
HOOC	SIGNAL C from fast controller	LRST	Reset Fast Machine
HDEL	.5 sec DELAY	LSTA	Select Talk Operationg for Fast Controller
LEMY	STEP MEMORY counter reads 31	HENF	Enable Fast Controller Output
		LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



A3
-hp- Part No. 59401-66503

Revisions A & B Boards

Δ1: Shaded area components do not exist on Rev. B boards; U106 is different between Rev. A & B Boards.

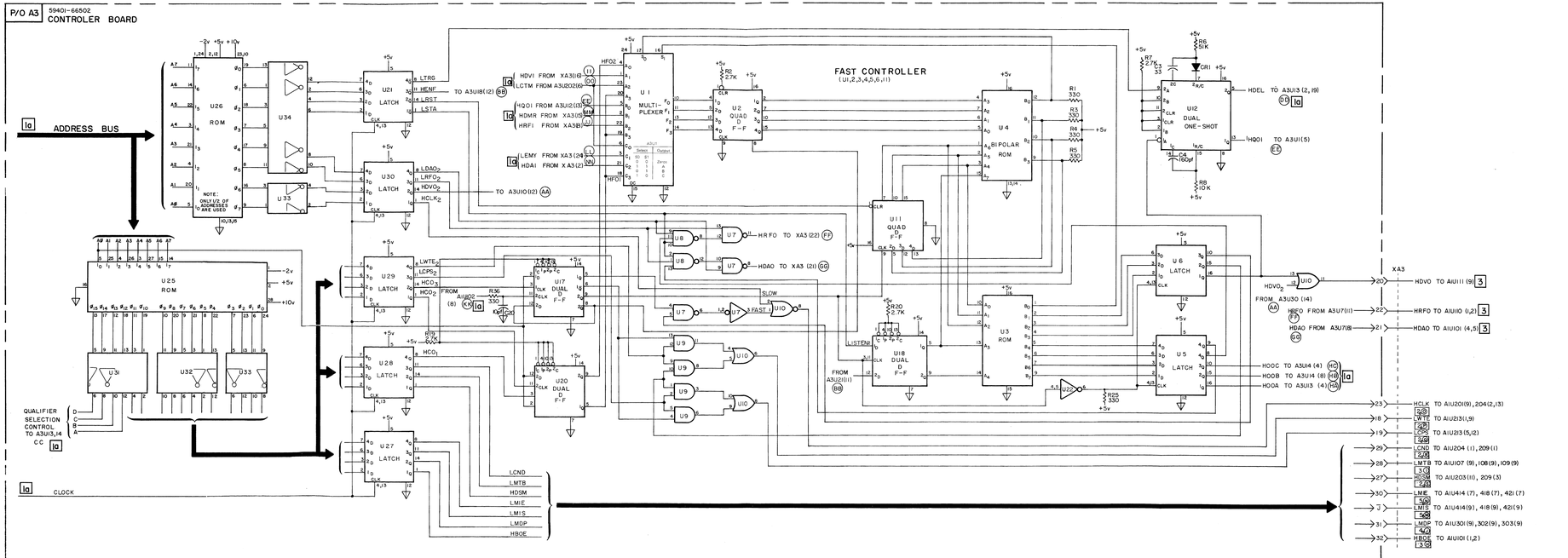


Figure 7-3. Controller, A3: Main/Fast Controller.

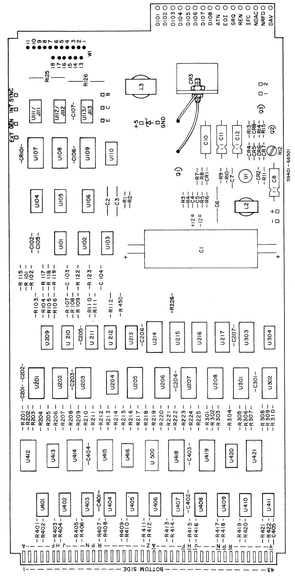
SIGNAL MNEMONICS

MAIN CONTROLLER

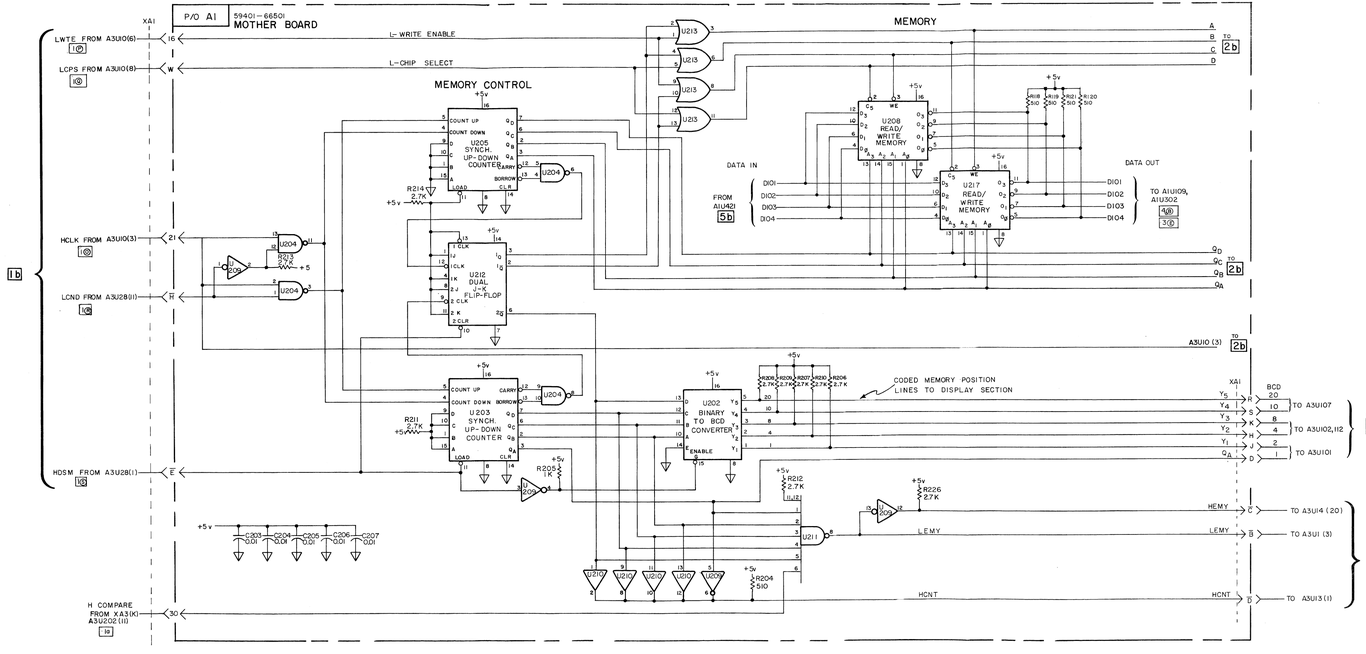
QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All 1's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



A1
-hp- Part No. 59401-66501



2a
Figure 7-4. Mother Board A1: Memory.

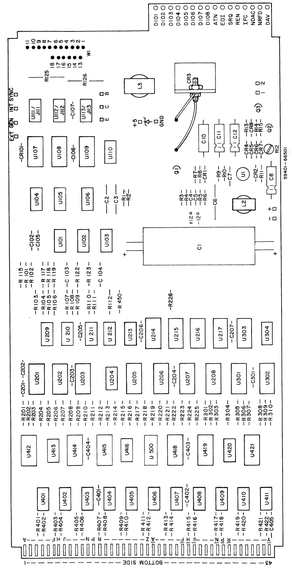
SIGNAL MNEMONICS

MAIN CONTROLLER

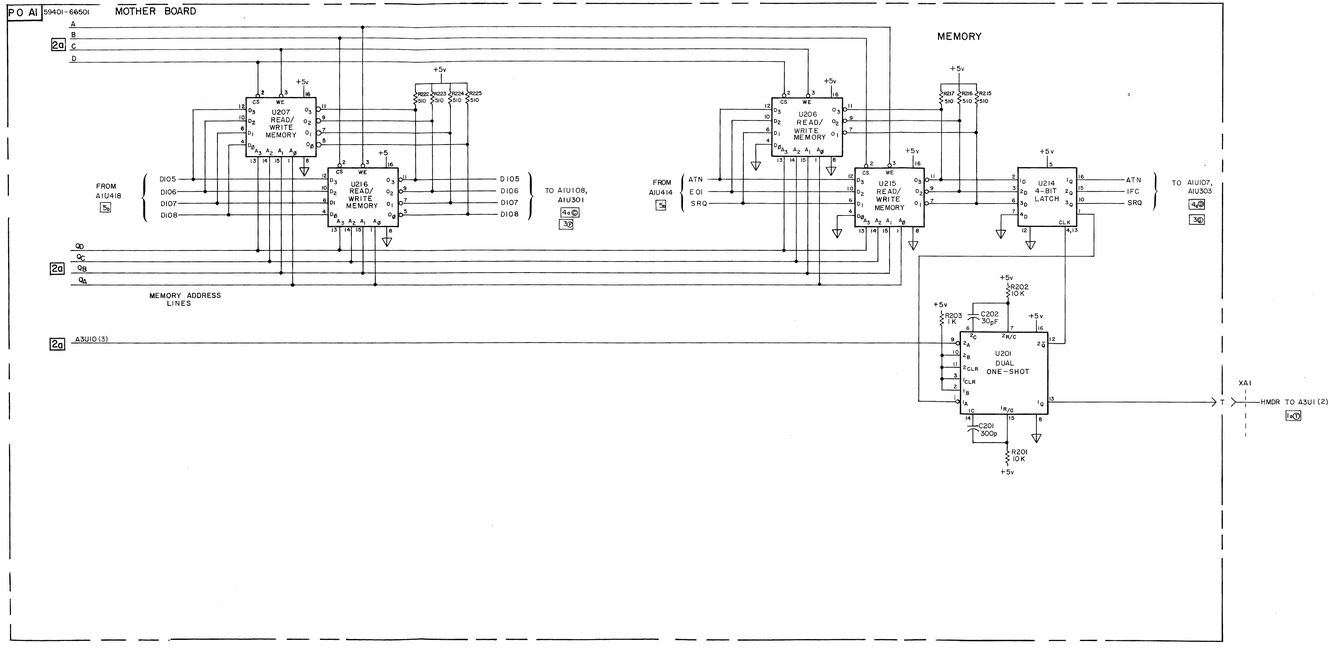
QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All I's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



A1
bp Part No. 59401-66501



2b
Figure 7-4. Mother Board A1: Memory (Cont'd).

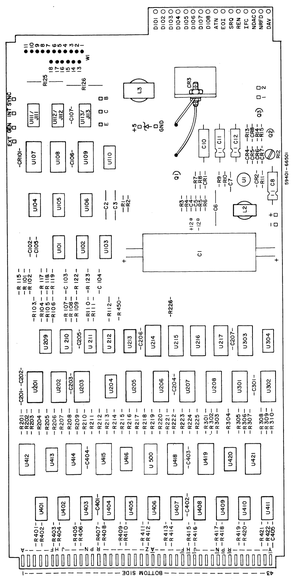
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All 1's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



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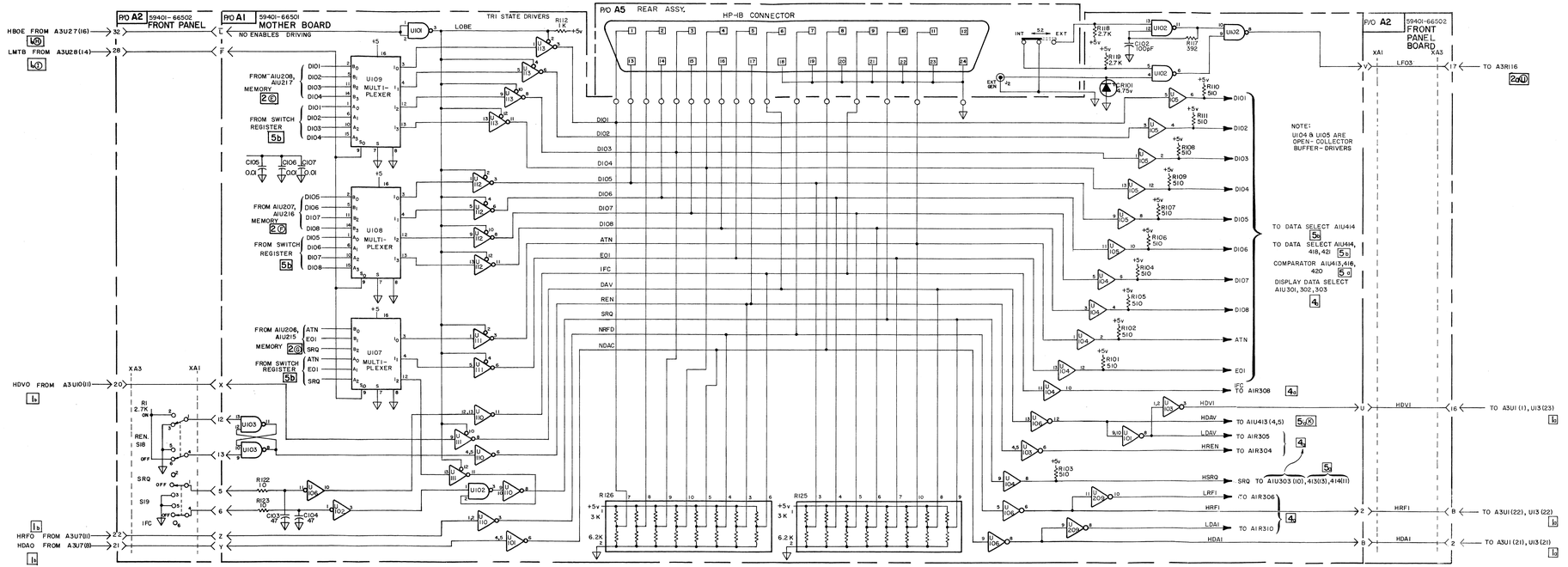


Figure 7-5. Mother Board A1: Bus I/O, Data Select.

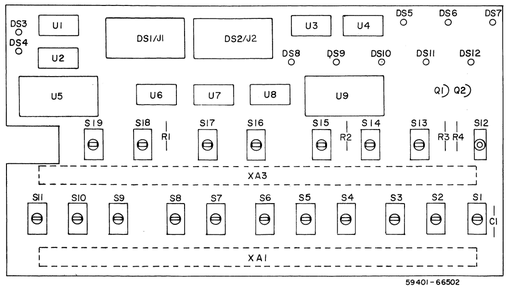
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All 1's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



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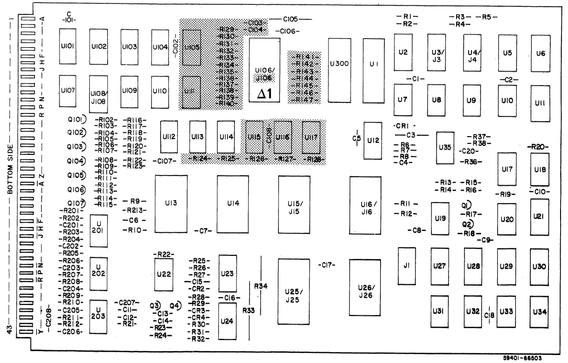
Δ1



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Revisions A & B Boards

Δ1: Shaded area components do not exist on Rev. B Boards; U106 is different between Rev. A & B Boards.

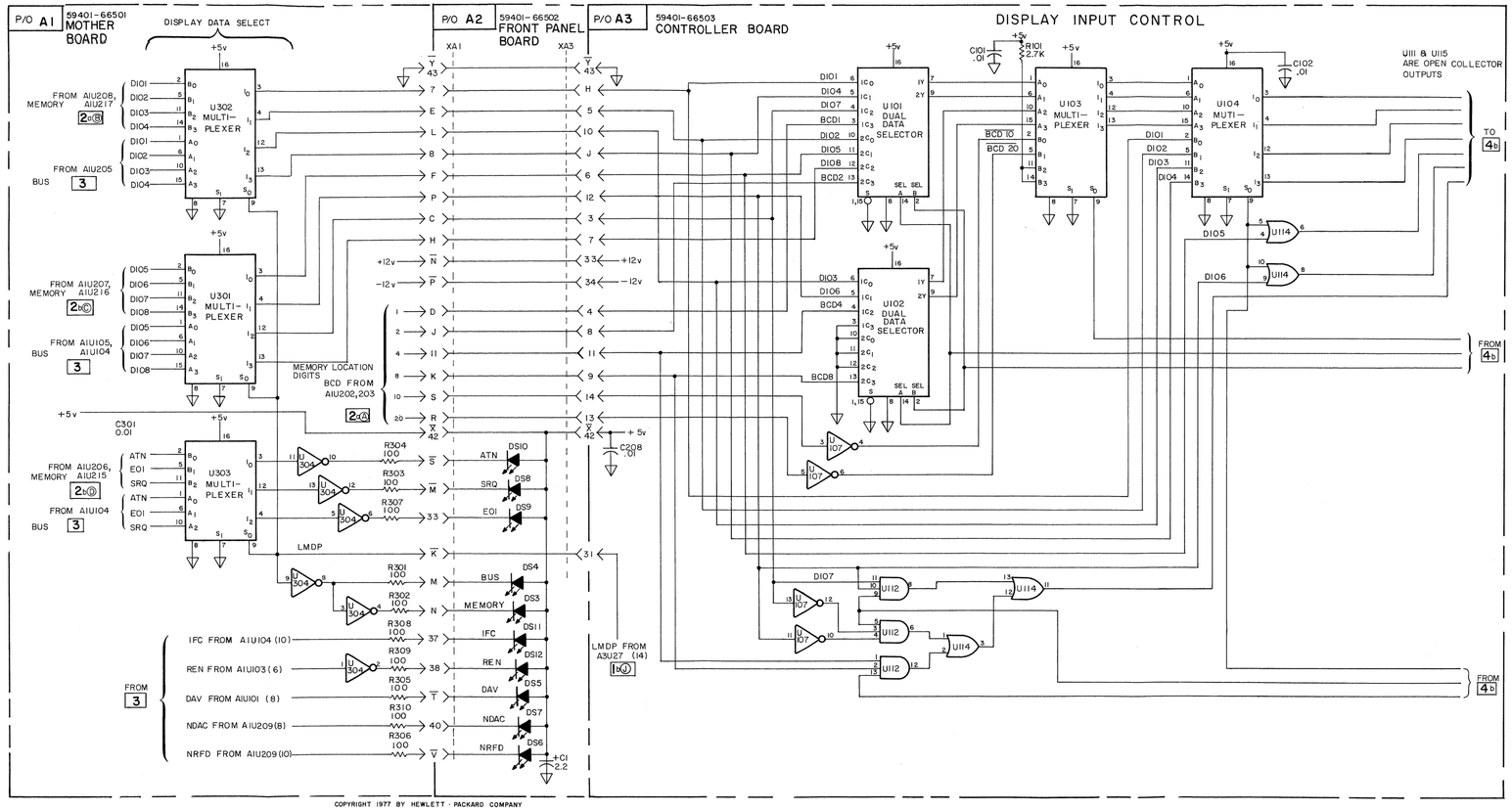

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Figure 7-6. Controller A3 Rev. A and B Boards; Display A2: Display Control.

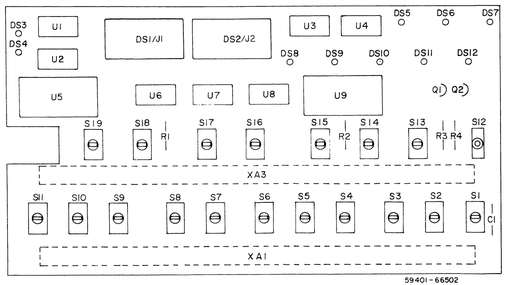
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All I's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



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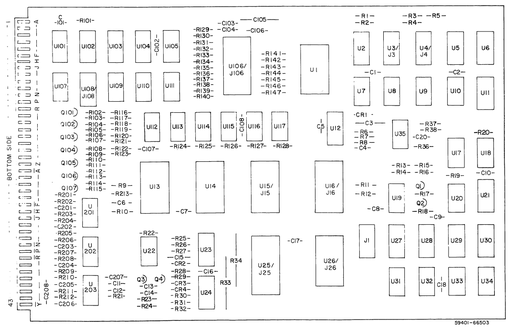

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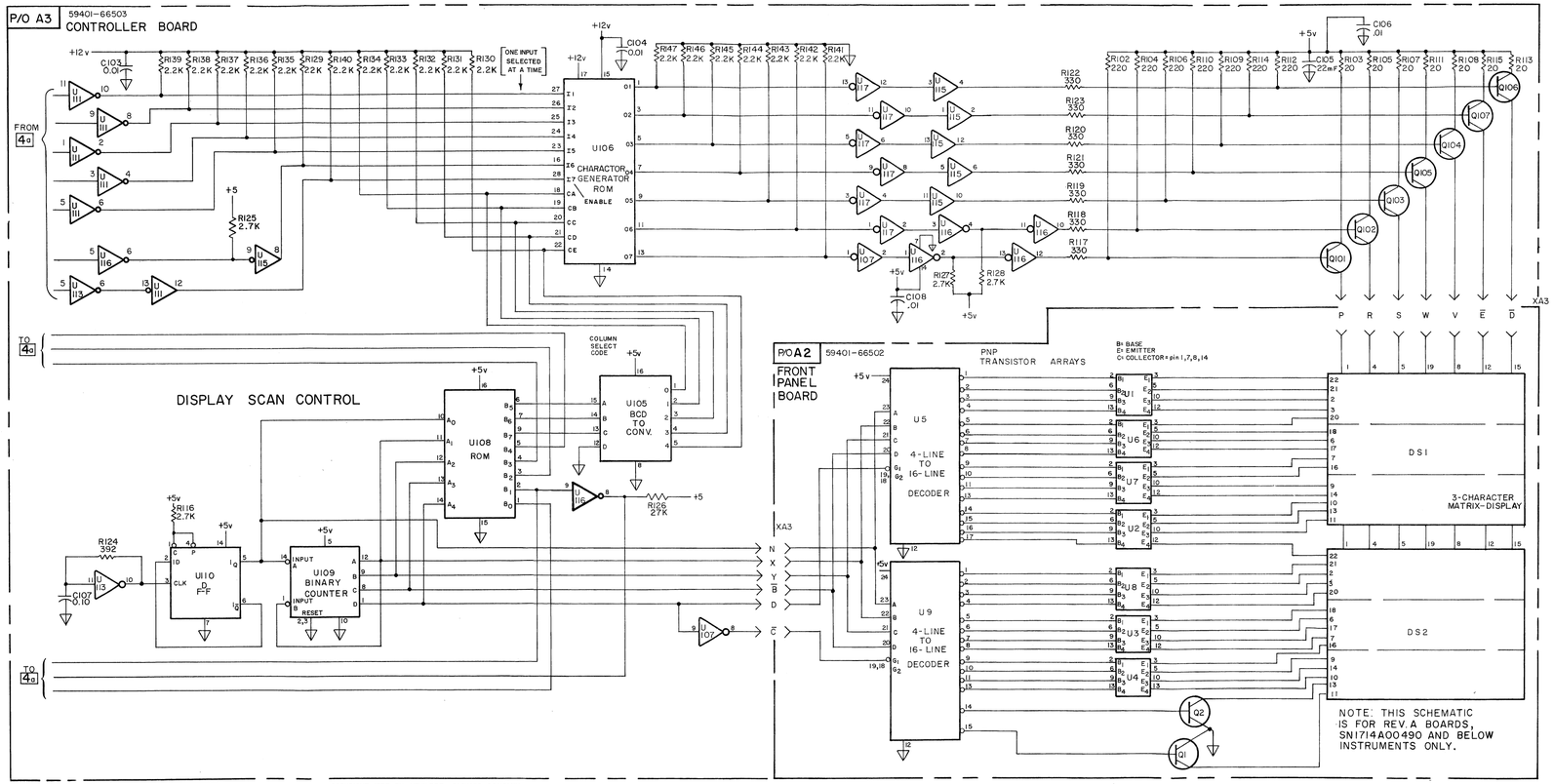


NOTE: THIS SCHEMATIC IS FOR REV. A BOARDS, SERIAL NUMBERS 1714A00490 AND BELOW INSTRUMENTS ONLY.

4b

Figure 7-6a. Controller A3 Rev. A Boards only, Display A2: Display Control (Cont'd)
Rev. B 7-39a

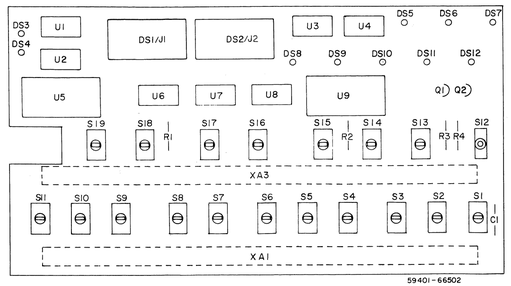
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All I's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



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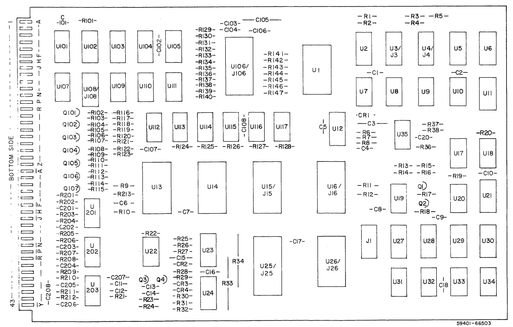

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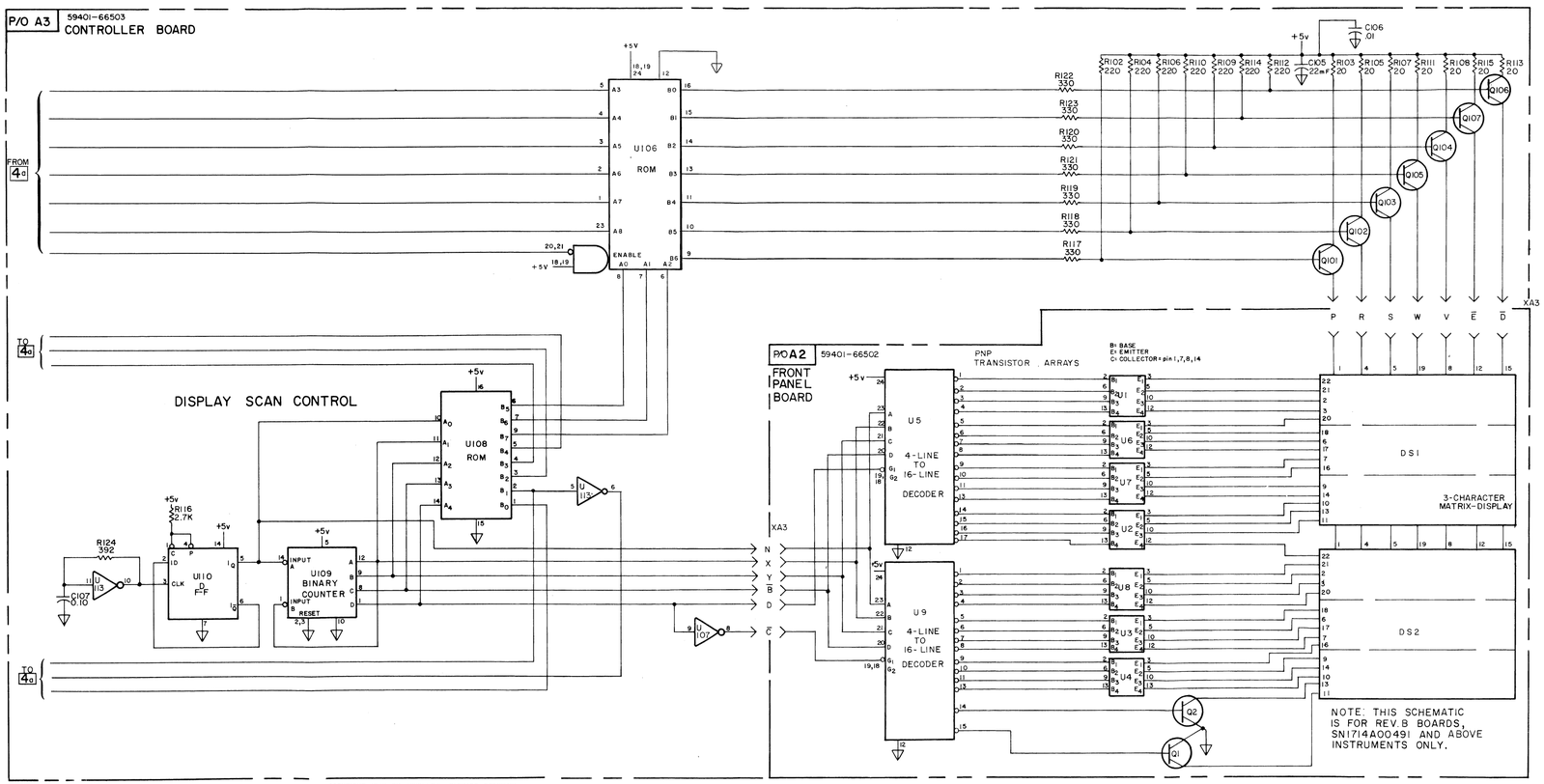
-hp- Part No. 59401-66503



NOTE: THIS SCHEMATIC IS FOR REV. B BOARDS, SERIAL NUMBERS 1714A00495 AND UP INSTRUMENTS ONLY.

Figure 7-6b. Controller A3 Rev. B Boards only, Display A2: Display Control (Cont'd).

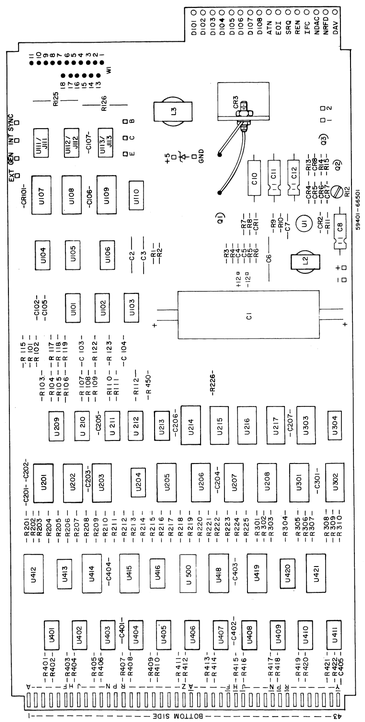
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All 1's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



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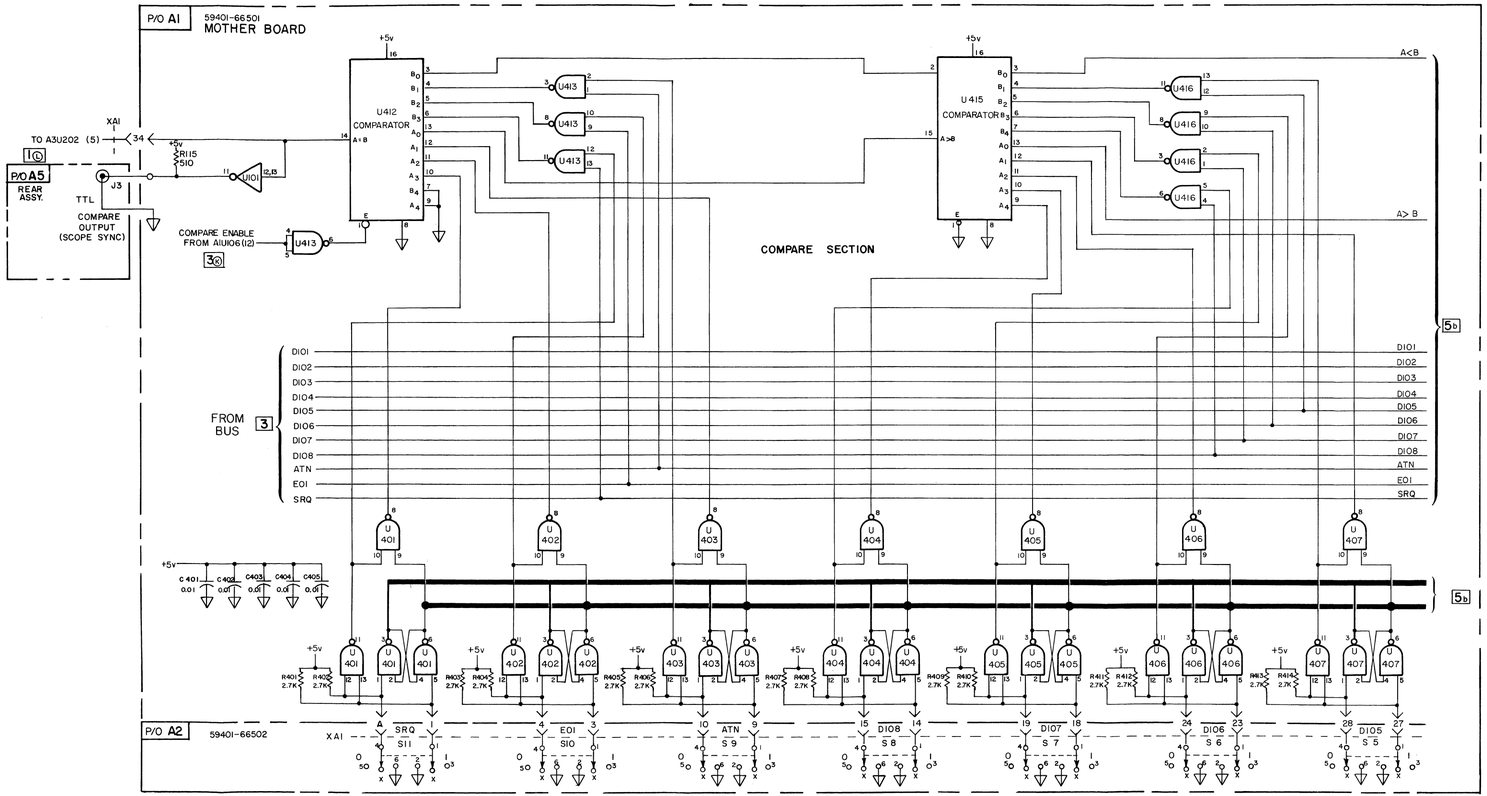


Figure 7-7. Mother Board A1: Compare.

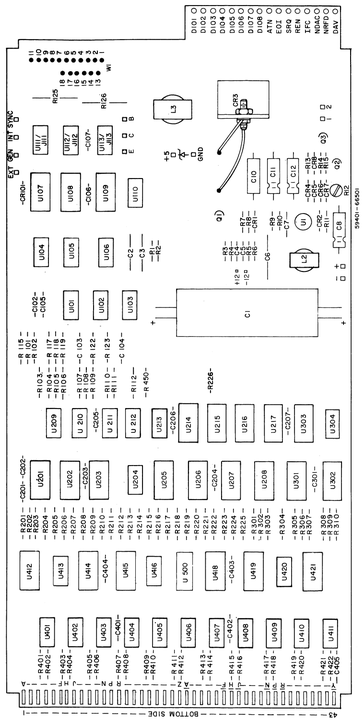
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All 1's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



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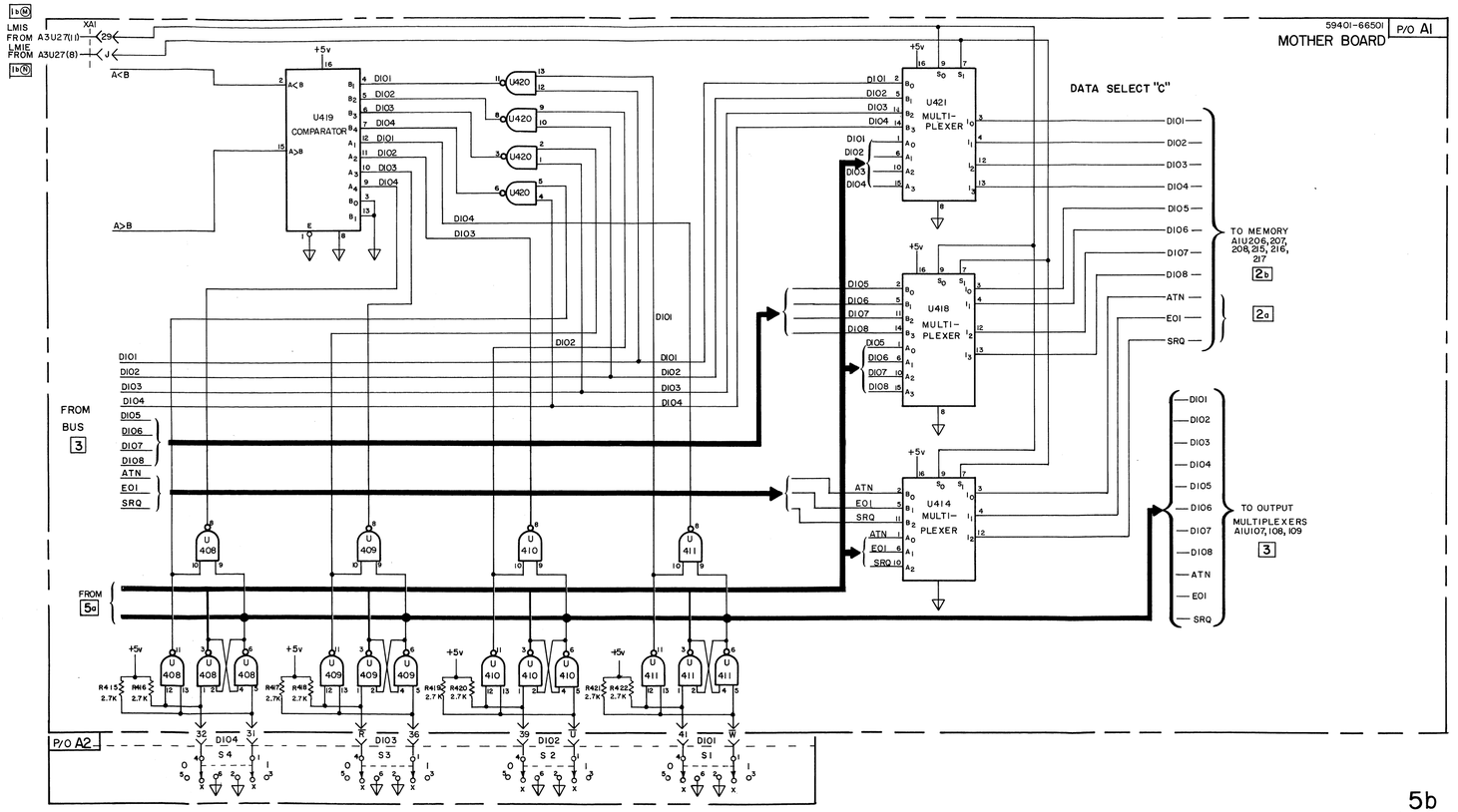

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Figure 7-7. Mother Board A1: Compare (Cont'd).

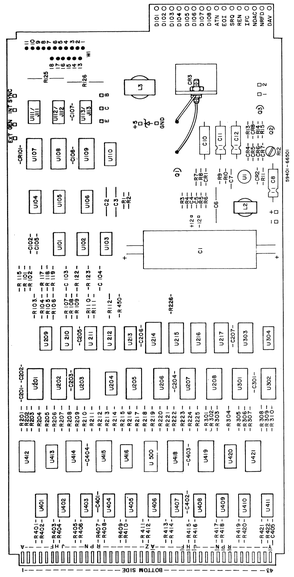
SIGNAL MNEMONICS

MAIN CONTROLLER

QUALIFIERS		INSTRUCTIONS	
LEXE	EXECUTE pressed	LBOE	Bus Output Enable
HSTF	STEP MEMORY FORWARD pressed	LMDP	Connects Memory Output to Display
HSTR	STEP MEMORY REVERSE pressed	$LWTE_2$	Enables Data to be Written into Memory
HCLR	CLEAR MEMORY pressed	$LCPS_2$	Selects a Location in Memory (Chip Select)
HTLK	TALK FUNCTION selected	LMIS	Connects Bus to Memory Input (Select)
HRSL	HALT selected	LMIE	Connects Panel Switches to Memory Input (Enable)
HRFS	RUN FAST selected	HMIS, HMIE	Applies All I's to Memory Input (Disable)
LRSL, LRFS	RUN SLOW selected	HDSM	Unblanks Memory Location Digits
HCMP	COMPARE switch on	$LCLK_2$	Clocks Memory Location Counters
LTCM	COMPARE switch on and comparison is true	$HDVO_2$	Drives LDAV True
HCNT	STEP MEMORY counter reads 30	$HRFO_2$	Drives HRFD False
HDVI	LDAV is true	$LDAO_2$	Drives HDAC False
HRFI	LNRFD is false (RFD is Low)	LMTB	Select Memory to Drive Bus
HDAI	LNDAC is false (DAC is Low)	LCND	Counts Memory in Reverse (Down)
HMEO	MEMORY off	HCO1	Clock F1
LMEO, LCLR	MEMORY on	HCO2	Clock F2
HOOA	SIGNAL A from fast controller	HCO3	Clock F3
HOOB	SIGNAL B from fast controller	LRST	Reset Fast Machine
HOOC	SIGNAL C from fast controller	LSTA	Select Talk Operationg for Fast Controller
HDEL	.5 sec DELAY	HENF	Enable Fast Controller Output
LEMY	STEP MEMORY counter reads 31	LTRG	Triggers .5 Second Delay

FAST CONTROLLER

QUALIFIERS		INSTRUCTIONS	
HQO1	Wait 500 ns After Changing Data	$HDVO_1$	LDAV is True
HDMR	Wait 1 μs After MRE Driven Low	$LRFO_1$	HDAC is True } if LSTA False (From MAIN CONTROLLER)
HRFI	RFD is False	$HRFO_1$	HRFD is False } if LSTA False (From MAIN CONTROLLER)
HFO1	Signal F1 From Main Controller	$LWTE_1$	Drives LWTE and LCPS True if LFO3 is True
HFO2	Signal F2 From Main Controller	$HCLK_1$	Drives HCLK True if HFO3 is True
HDAI	HDAC is False	HOOA	Signal A to Main Controller
LTCM	Compare Switch on and Comparison is True	HOOB	Signal B to Main Controller
LEMY	Compare Switch on and Last Memory Location is Sent	HOOC	Signal C to Main Controller
HDVI	LDAV is True		
HENF	Enable Fast Controller Output		
LSTA	Fast Controller Should Select Talk Operation		



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-hp- Part No. 59401-66501

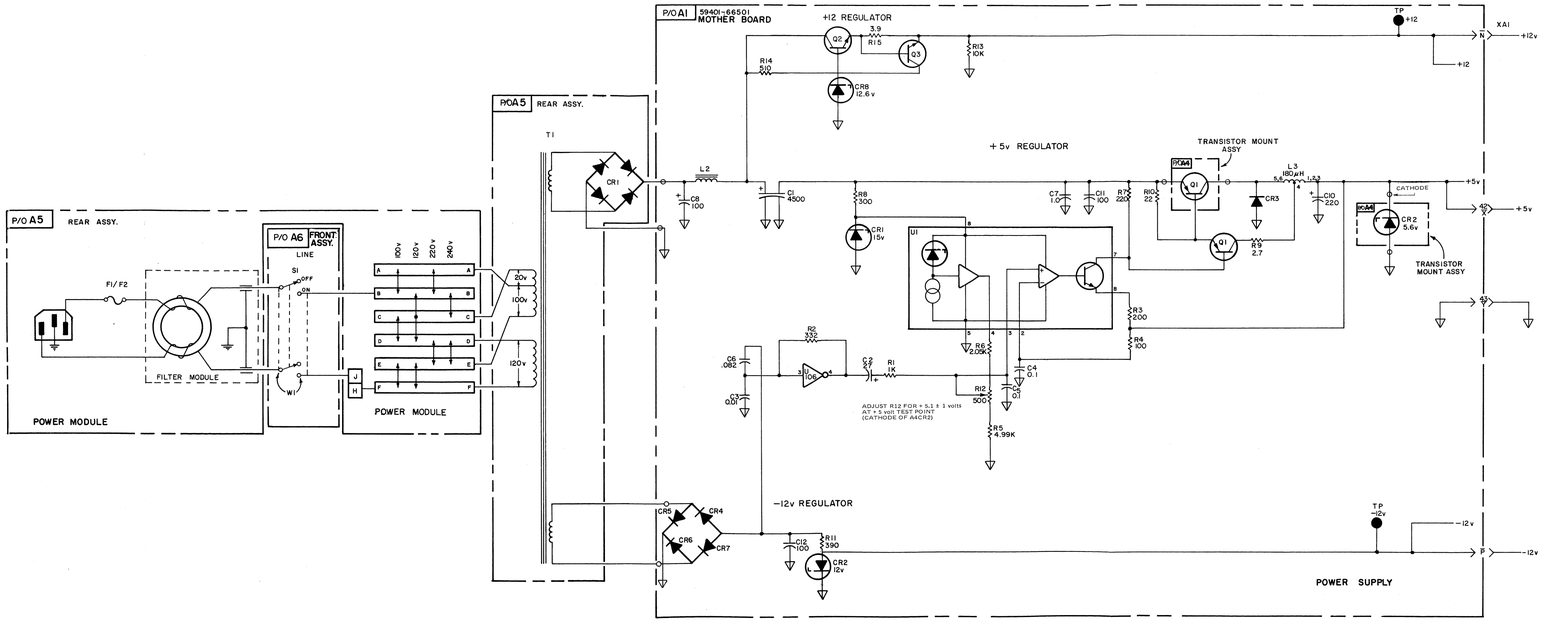

Figure 7-8. Power Supply A1.

APPENDIX A

VERIFYING BUS INSTRUMENT INTERFACE FUNCTIONS

INTRODUCTION.

The Model 59401A Bus System Analyzer is the ideal instrument for verifying that another bus instrument performs its designed interface functions in accordance with IEEE Standard 448-1975. This appendix provides a detailed procedure for performing such a verification.

Any questions the user may have regarding interface functions are answered in the standard, copies of which may be ordered from

The Institute of Electrical and Electronic Engineers, Inc.
345 East 47th Street
New York, New York 10017

SECTION I

ACCEPTER HANDSHAKE INTERFACE FUNCTION

1-1. DESCRIPTION.

1-2. The Accepter Handshake Interface Function, in conjunction with the Source Handshake Interface Function, is used to guarantee the proper reception of remote multiline messages by a "listen" device. The Accepter and Source Handshake Interface Functions interlock to permit asynchronous transfer of each data byte. The Accepter Handshake Interface Function may delay the initiation or termination of a message transfer until the "listen" device is prepared to continue with the transfer process. The Accepter Handshake Interface Function controls the message transfer process by means of the DAV, NRFD, and NDAC control lines.

1-3. Accepter Handshake Interface Codes.

1-4. The code "AH" is used to identify the Accepter Interface Function. Two codes are used to denote the capability of a particular device to the Hewlett-Packard Interface Bus. These are AH0 which indicates the device has no Accepter Handshake capability and AH1 which denotes the device has complete Accepter Handshake capability.

1-5. Accepter Handshake Interface Function Requirements and Tests.

a. The device under test must not drive the NRFD and NDAC outputs low (true) when power is initially applied and before any messages are sent on the Bus.

NOTE

Devices with "listen only" capability, such as those classified L1, L3, LE1, or LE3, must not be in the "listen only" mode for this test.

TEST:

1. Set the Bus System Analyzer to the TALK/HALT/MEMORY–OFF mode and connect it to the HP–IB connector of the device to be tested.
2. Set all switches in the lower switch register of the Analyzer to the "0" position.
3. Apply power to the device under test and observe that the NRFD and NDAC indicators on the Bus Analyzer do not light.

b. When the device under test is not addressed to "listen" or active, it must be set NDAC low (true) within 200 nanoseconds after receiving an ATN low (true) signal. NDAC and NRFD must be high (false) when ATN is high (false).

NOTE

Devices with "listen only" capability, such as those classified L1, L3, LE1, or LE3, must not be in the "listen only" mode for this test.

TEST:

1. Set the Bus System Analyzer to the TALK/HALT/MEMORY–ON mode and momentarily switch the SRQ/IFC switch to IFC.

2. Connect the 59405-66503 Test Card to the Bus cable at the instrument under test.

3. Adjust the Pulse Generator controls to obtain a 100 kHz square wave and minimum output. Connect the Generator OUTPUT between the GND and ATN test point on the test card. Adjust the AMPLITUDE and DC OFFSET controls of the Generator to obtain a signal amplitude of 0 to + 5 volts.

4. Connect the Oscilloscope vertical inputs to the test card ATN and NDAC test points. Adjust the Scope to trigger on the negative-going portion of the ATN signal. The time between the negative–going portion of the ATN signal and the negative–going portion of the NDAC signal must be less than 200 nano–seconds.

5. Remove the Function Generator from the ATN test point and set the Bus Analyzer to TALK/HALT/MEMORY–OFF. The NDAC and NRFD indicators must be unlit.

c. When the device under test is not addressed to "listen" or active and ATN is low (true), it must "handshake" as a data accepter to valid data transmitted on the Bus. NRFD must be set low (true) only after DAV has gone low (true) but before or at the same time NDAC is set high (false). NDAC must be set low (true) only after DAV has gone high (false) but before or at the same time NRFD is set high (false).

TEST:

1. Set the Bus System Analyzer to the TALK/HALT/MEMORY–ON mode. Load octal code "ATN 001" into memory location "00". Load octal code "ATN 000" into all other memory locations. Switch the memory OFF.

2. Set the lower switch register of the Bus Analyzer to octal code "ATN 001" and switch to TALK/FAST/COMP–OFF.

3. Use the Bus Analyzer COMPARE OUTPUT signal to externally trigger the Oscilloscope. Connect the Oscilloscope vertical inputs to the DAV and NRFD test points on the 59405-66503 Test Card. The NRFD signal must go low (true) only after the DAV signal has gone low (true).

4. Remove the Oscilloscope input from the NRFD test point and connect it to the NDAC test point. The NDAC signal must go low (true) only after the DAV signal has gone high (false).

5. Remove the Oscilloscope input from the DAV test point and connect it to the NRFD test point. NRFD must go low (true) before or at the same time NDAC goes high (false). NDAC must go low (true) before or at the same time NRFD is set high (false).

d. The device under test must "handshake as a data accepter when ATN is high (false) and the device is addressed to "listen".

TEST:

1. Set the Bus System Analyzer to the TALK/HALT/MEMORY–ON mode. Load octal code "001" into memory location "00". Load octal code "000" into all other memory locations and switch the memory OFF.

2. Momentarily switch the analyzer SRQ/IFC switch to IFC. Set the lower switch register to the listen address of the device being tested, set the ATN switch to "1", and momentarily press the EXECUTE button.

NOTE

If the device under test has extended listener capability, such as those classified LE1 through LE4, both a primary and secondary listen address are required to address the device to listen. Devices with listen only capability, such as those classified L1, L3, LE1, or LE3, do not need to be addressed to listen if the "lon" (listen only) message is true.

3. Set the Analyzer to the TALK/FAST/COMP–OFF mode. Set the lower switch register to octal code "001".

4. Use the Bus Analyzer COMPARE OUTPUT to externally trigger the Oscilloscope. Connect the Oscilloscope vertical inputs to the DAV and NRFD test points on the test card. The NRFD signal must go low (true) only after the DAV signal has gone low (true).

5. Remove the Oscilloscope input from the NRFD test point and connect it to the NDAC test point. The NDAC signal must go low (true) only after the DAV signal has gone high (false).

6. Remove the Oscilloscope input from the DAV test point and connect it to the NRFD test point. NRFD must go low (true) before or at the same time NDAC goes high (false). NDAC must go low (true) before or at the same time NRFD goes high (false).

LISTENER AND EXTENDED LISTENER INTERFACE FUNCTION

2-1. DESCRIPTION.

2-2. The Listener Interface Function provides a device with the capability to receive device dependent data (including status data) over the Interface from other devices. This capability exists only when the function is addressed to "listen". There are two alternative versions of the Function, one with and one without address extension. The normal Listener Interface Function uses a one-byte address. The Listener Interface Function with address extension (Extended Listener Function) uses a two-byte address.

2-3. Listener Interface Function Codes.

2-4. The basic code used to identify the Listener Interface Function is "L", while the basic code for the Extended Listener Interface Function is "LE". The codes used to identify the Listener or Extended Listener Interface Function capability of a particular device are L0 or LE0 which indicates the device has no Listener or Extended Listener Interface capability; and L1 through L4 or LE1 through LE4 which indicate various specified capabilities.

2-3. Listener Interface Function Requirements and Tests.

a. When power is first applied, the device under test must *not* "come on" addressed to "listen". *This test applies to devices classified L1 through L4 or LE1 through LE4.*

NOTE

The device under test must **not** *be in the "listen only" mode for this test.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–ON and connect it to the HP–IB connector of the device under test.

2. Connect the 59405-66503 test card to the Bus cable at the instrument under test.

3. Apply power to the device under test. The device must *not* drive the NRFD or NDAC lines low (true). The Analyzer NRFD and NDAC indicators must be unlit.

b. The device under test must become addressed to "listen" if the IFC message is false and the Listen Only message (lon) is true. *This test applies to devices classified L1, L3, LE1, or LE3.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set all switches in the lower switch register to the "0" position and momentarily switch the SRQ/IFC switch to IFC.

2. Switch the "listen only" mode of the device under test to ON. The device must drive the NDAC line low (true). The Analyzer NDAC indicator must light.

3. Press and hold the Analyzer EXECUTE button. The device must stop driving the NDAC line low (true) and drive the NRFD line low (true). The Analyzer NDAC indicator must be unlit and the NRFD indicator must light.

c. When in the "listen only" mode, the device under test must become unaddressed to listen in less than 100 microseconds after receiving IFC low (true). *This test applies to devices classified L1, L3, LE1, or LE3 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–ON.

2. Adjust the Pulse Generator controls to obtain a square wave with a negative pulse width of 100 microseconds (5 kHz) and an amplitude of 0 to + 5 volts. Connect the Generator OUTPUT between the GND and IFC test point on the Test Card.

3. Connect the Oscilloscope vertical inputs to the Test Card IFC and NDAC test points. Trigger the Oscilloscope on the negative–going edge of the IFC signal. The NDAC signal must go high (false) in less than 100 microseconds after the IFC signal goes low (true).

4. Disconnect the Function Generator from the Analyzer and set the "listen only" switch of the device under test to OFF.

d. The device under test must become addressed to "listen" if the IFC message is false, the listen message (ltn) is true, and the device is an active controller. *This test applies to devices classified L3, L4, LE3, or LE4.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT. Activate the device under test as a controller. The device under test must drive the ATN line low (true) if it is an active controller. The Analyzer ATN indicator will be lit.

2. Press and hold the Analyzer EXECUTE button to accept a character from the Bus. The device under test must drive the NDAC line low (the NRFD line will be driven low by the Analyzer). The Analyzer NDAC and NRFD indicators must be lit.

3. Release the Analyzer EXECUTE button. The device under test must drive the NRFD line low. (The NDAC line will be driven low by the Analyzer.) The Analyzer NDAC and NRFD indicators must be lit.

e. If the device under test is an active controller addressed to listen, and the "listen only" (lon) and "local listen" (ltn) messages are false, it must become unaddressed to listen if the "local unlisten" message (lun) is true. *This test applies to devices classified L3, L4, LE3, or LE4 only.*

TEST:

1. Put the device under test in an active control mode such that it will address itself to listen and then send other Bus commands.

2. Set the Analyzer to LISTEN/HALT and accept characters from the Bus by pressing the EXECUTE button. The device under test should drive ATN and DAV low (true) if the "local unlisten" message is true.

3. After several Bus Commands have been accepted, switch the Analyzer to TALK/HALT/MEMORY–OFF and set all switches in the lower switch register to "0". The device under test must not drive the NRFD and NDAC lines low. (The Analyzer NRFD and NDAC indicators must be unlit.)

f. The device under test must become addressed to "listen" if the ATN and DAV signals are true, the IFC message is false, and the DIO lines contain the device's listen address code. The device must *not* become addressed to listen when listen address codes other than its own are received. *This test applies to devices classified L1 through L4 or LE1 thorugh LE4.*

NOTE

The "listen" address code is an eight digit binary code in the form X, 0, 1, A5, A4, A3, A2, A1 where "X" can take on the value of "0" or "1" and A5 through A1 contain the code for a particular device. The Extended Listener also requires a secondary listen address code in the form X, 1, 1, S5, S4, S3, S2, S1.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–ON. Clear the memory and load consecutive listen address codes into alternate memory locations. (See Table 2-1.) Exclude the listen address of the device under test. If the device is an Extended Listener, load consecutive primary listen addresses, excluding the primary listen address of the device under test and the secondary listen address of the device into alternate memory locations. (See Table 2-1.)

2. Switch the memory OFF and the COMP switch to ON. Momentarily switch the SRQ/IFC switch to IFC. Set all switches in the lower switch register to the "X" position and the FAST/SLOW/HALT switch to FAST.

3. Output each character from memory by pressing the EXECUTE button. The device under test must drive NRFD low (true) when ATN and DAV are low (EXECUTE button released) and NDAC low (true) when only ATN is low (EXECUTE button held in). Neither NDAC nor NRFD should be driven low when ATN is high (false).

4. Repeat Steps 1, 2, and 3 until all listen address codes, except the listen address of the device under test and the "unlisten" command have been checked. This test verifies the device will not become addressed to listen by listen addresses other than its own.

Table 2-1. No–Listen Test Pattern.

STANDARD LISTENER		EXTENDED LISTENER	
Memory Location Number	Memory Contents (octal code)	Memory Location Number	Memory Contents (octal code)
00	ATN 040	00	ATN 040
01	000	01	ATN 171 – – – secondary listen
02	ATN 041	02	000 address of device
03	000	03	ATN 041 under test
04	ATN 042	04	ATN 171
		05	000
28	ATN 056		
29	000	26	000
30	ATN 057	27	ATN 051
31	000	28	ATN 171
		29	000
		30	ATN 052
		31	ATN 171

5. If the device is an Extended Listener, repeat Steps 1 through 4 to load consecutive secondary listen address of the device under test. (See Table 2-2.)

Table 2-2. Extended No–Listen Test Pattern.

EXTENDED LISTENER	
Memory Location Number	Memory Contents (octal code)
00	ATN 052 - - - primary listen address
01	ATN 140 of device under test
02	000
03	ATN 052
04	ATN 141
05	000
26	000
27	ATN 052
28	ATN 151
29	000
30	ATN 052
31	ATN 152

6. Switch the Analyzer to TALK/HALT/MEMORY–ON and load the listen address of the device under test in memory location "00". (If the device is an Extended Listener, load the primary listen address in memory location "00" and the secondary listen address in location "01". The memory should now contain the listen address of the device under test and other listen addresses in alternate memory locations. (See Table 2-3.)

7. Turn the memory OFF, set all lower switches to the "X" position, and set the Analyzer to TALK/FAST.

Table 2-3. Listen Test Pattern.

STANDARD LISTENER		EXTENDED LISTENER	
Memory Location Number	Memory Contents (octal code)	Memory Location Number	Memory Contents (octal code)
00	ATN 052---listen address	00	ATN 052---primary and
01	000 of device	01	ATN 152 secondary
02	ATN 061 under test	02	000 listen address
03	000	03	ATN 052 of device
04	ATN 062	04	ATN 165 under test
		05	000
		06	ATN 052
		07	ATN 166
28	ATN 075		
29	000	27	ATN 052
30	ATN 076	28	ATN 175
31	000	29	000
		30	ATN 052
		31	ATN 176

8. Output each character from memory by pressing the EXECUTE button. The device under test, if addressed to listen, must drive NRFD low (true) when DAV is low (EXECUTE button released) and drive NDAC low (true) when DAV is high (EXECUTE button held in) whether ATN is high or low.

g. The device under test must become unaddressed to "listen" upon receiving the Unlisten Command (UNL). *This test applies to devices classified L1 through L4 or LE1 through LE4.*

NOTE

The device under test must **not** *be in the "listen only" mode for this test.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–ON and load the following program into memory:

Table 2-4. Listen/Unlisten Test Pattern.

STANDARD LISTENER		EXTENDED LISTENER	
Memory Location Number	Memory Contents (octal code)	Memory Location Number	Memory Contents (octal code)
00	ATN 052---listen address	00	ATN 052---primary and
01	000 of device	01	ATN 152 secondary
02	ATN 077 under test	02	000 listen address
03	000	03	ATN 077 of device
04	ATN 052	04	000 under test
		05	ATN 052
27	000	06	ATN 152
28	ATN 052		
29	000	28	ATN 077---unlisten
30	ATN 077--- unlisten	29	000 address
31	000 address	30	ATN 052
		31	ATN 152

2. Switch the Analyzer memory OFF and set the COMP switch to ON. Set all switches in the lower switch register to the "X" position and momentarily switch the SRQ/IFC switch to IFC.

3. Set the Analyzer to TALK/FAST and output each character from memory by pressing the EXECUTE button. The device under test must drive NDAC low (true) when ATN is low and DAV is high (when a command is present on the Bus but data has not been made valid). The device must drive NRFD low (true) when ATN and DAV are low. After the device has become addressed to listen (as at memory location "01" for the Standard Listener, or memory location "02" for the Extended Listener), it must drive NDAC low (true) when DAV is high (false) and drive NRFD low (true) when DAV is low (true). After the device has become unaddressed to listen (as at memory location "03" for the Standard Listener, or memory location "04" for the Extended listener), it must *not* drive NDAC or NRFD low whether DAV is high or low.

h. The device under test must become unaddressed to listen within 100 microseconds after receiving IFC low (true). *This test applies to devices classified L1 through L4 and LE1 through LE4.*

NOTE

The device under test must **not** *be in the listen only mode for this test.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–ON and load the following program into memory:

Table 2-5. Listen Response Time Test Pattern.

STANDARD LISTENER			EXTENDED LISTENER		
Memory Location Number	Memory Contents (octal code)		Memory Location Number	Memory Contents (octal code)	
00	ATN 052	listen address	00	ATN 052	primary and
01	000	of device	01	152	secondary
02	ATN 052	under test	02	000	listen address
03	000		03	ATN 052	of device
04	ATN 052		04	ATN 152	under test
28	ATN 052		05	000	
29	000				
30	ATN 052		27	ATN 052	
31	000		28	ATN 152	
			29	000	
			30	ATN 052	
			31	ATN 152	

2. Set the Analyzer MEMORY and COMP switches OFF. Set all lower switches to the "0" position and switch the Analyzer to TALK/FAST.

3. Adjust the Pulse Generator controls to obtain a square wave with an amplitude of 0 to + 5 volts.

4. Set the Analyzer rear panel clock switch to EXTERNAL CLOCK and connect the Generator to the EXTERNAL CLOCK INPUT. Connect the Analyzer COMPARE OUTPUT to the IFC test point on the 59405–66503 Test Card.

5. Connect the Oscilloscope vertical inputs to the Test Card IFC and NDAC test points. Adjust the Generator frequency to obtain an IFC signal with a negative pulse width of 100 microseconds. Trigger the Oscilloscope on the negative–going edge of the IFC signal. The NDAC signal must go high (false) within 100 microseconds after IFC goes low (true).

6. Remove the Oscilloscope and Pulse Generator connections from the Test Card. Remove the connection between the COMPARE OUTPUT and IFC test point and return the clock switch to INTERNAL CLOCK.

i. The device under test must become unaddressed to listen and become addressed to talk upon receiving its talk address code. *This test applies to devices classified L3, L4, LE3, or LE4 only.*

NOTE

The device under test must **not** *be in the "listen only" mode for this test.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and momentarily switch the SRQ/IFC switch to IFC. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. (If the device is an Extended Listener, both a primary and secondary listen address must be sent.)

2. Set the Analyzer ATN switch to the "0" position. The device under test must drive NDAC low (true) and NRFD high (false) indicating it is addressed to listen.

3. Set the Analyzer lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. (If the device is an Extended Talker, both a primary and secondary talk address must be sent.) Set the ATN switch to "0". The device under test must *not* drive NDAC or NRFD low (true). The Analyzer NDAC and NRFD indicators must be unlit.

NOTE

When the device under test becomes an active talker and the ATN signal is high, it may drive the DIO lines at Bus speeds. The Analyzer digital display may be a blur.

SOURCE HANDSHAKE INTERFACE FUNCTION

3-1. DESCRIPTION.

3-2. The source Handshake Interface Function, in conjunction with the Accepter Handshake Interface Function, is used to guarantee the proper transfer of multiline messages. An interlocked handshake sequence between the Source Handshake Interface Function and one or more Accepter Handshake Interface Functions (each contained within separate devices) guarantees asynchronous transfer of each multiline message. The Source Handshake Interface Function controls the initiation of, and termination of, the transfer of a multiline message byte. This function utilizes the DAV, NRFD, and NDAC messages to effect each message byte transfer.

3-3. Source Handshake Interface Function Codes.

3-4. The basic code "SH" is used to identify the Source Handshake Interface Function. Two codes are used to denote the capability of the Source Handshake Interface Function of a particular device to the Hewlett-Packard Interface Bus. These are SH0, which indicates the device has no Source Handshake capability; and SH1, which indicates the device has complete Source Handshake capability.

3-5. Source Handshake Interface Function Requirements and Tests.

a. The device under test must *not* drive the DAV, EOI, or DIO lines low (true) when power is initially applied and before any messages are sent on the Bus.

NOTE

Devices with "talk only" capability, such as those classified T1, T3, T5, T7, TE1, TE3, TE5, or TE7, must **not** *be in the "talk only" mode for this test.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT/MEMORY–OFF and connect it to the HP–IB connector of the device under test.

2. Connect the 59405–66503 Test Card to the Bus cable at the instrument under test.

3. Apply power to the Device being tested and observe that the DAV, ATN, and EOI indicators do not light. The numeric display should read "000".

b. The device under test may set DAV low (true) only if NRFD is high (false) and the data on the DIO lines is valid. This applies to devices which are active "talkers" or "controllers" or are in an active serial poll mode.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

NOTE

If the device under test is an extended talker, both a primary and secondary talk address is required. If the device is a controller, it must be programmed to send a repetitive sequence when in active control. (Refer to the operating manual of the device under test for programming information.)

2. Switch the Analyzer to LISTEN and single step the output of the device to find a unique character such as the ASCII character "CR" (octal code 015).

3. Set the Analyzer lower switch register to the code of the character selected and switch to LISTEN/FAST/COMP–OFF.

4. Connect the Oscilloscope vertical inputs to the DAV and NRFD test points on the Test Card. Use the Analyzer COMPARE OUTPUT to trigger the Oscilloscope. NRFD must go high (false) before DAV goes low (true).

5. Remove the Oscilloscope input from the NRFD test point and connect it to a DIO test point which will go low (true) for the character selected. For example,

the DIO lines DIO1, DIO3, and DIO4 will be low for the character "CR" (octal code 015). DAV must *not* go low (true) for more than 2 microseconds after the DIO line selected goes low (true).

NOTE

If tri–state drivers are used to drive the DAV, DIO, and EOI lines, this time may be reduced. Refer to the Hewlett-Packard Interface Bus Manual, Page 93, for particular timing values.

NOTE

This test only applies to devices which can continuously output data when addressed to talk.

c. The device under test may set DAV high only after NDAC has gone high (false).

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

NOTE

If the device is an extended talker, a secondary talk address is required. If the device is an active controller, it must be programmed to repetitively output commands.

2. Connect the Oscilloscope vertical inputs to the NDAC and DAV test points on the Test Card. Set the Analyzer to LISTEN/FAST/COMP–OFF.

3. Trigger the Oscilloscope on the positive–going edge of the NDAC signal. Observe that the NDAC signal goes high (false) before the DAV signal goes high (false).

d. Data may be changed at the same time or after DAV goes high, but it must be changed before DAV is again set low.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

NOTE

If the device is an extended talker, a secondary talk address is required. If the device is an active controller, it must be programmed to repetitively output commands.

2. Connect the oscilloscope vertical inputs to the DAV test point and an active DIO test point on the Analyzer rear panel. Set the Analyzer to LISTEN/FAST/COMP–OFF.

3. Trigger the Oscilloscope on the positive–going edge of the DAV signal. Observe that the DIO signal does not change before the DAV signal goes high.

4. Trigger the Oscilloscope on the negative–going edge of the DAV signal. Observe that the DIO signal does not change after the DAV signal has gone low.

5. Trigger the Oscilloscope on the negative–going edge of the DIO signal. Observe that the DIO signal goes low more than 2 microseconds before the DAV signal goes low.

NOTE

If tri-state drivers are used to drive the DAV, DIO, and EOI lines, this time may be reduced to 1100 nanoseconds or greater. If the device being tested is a controller and uses tri-state drivers to control the DAV, DIO, EOI, and ATN lines, the time may be reduced to 700 nanoseconds or greater for the first byte of information output and 500 nanoseconds or greater for subsequent bytes of information.

e. If the device under test is an active talker, it must stop driving the DIO, DAV, and EOI lines in less than 200 nanoseconds after ATN goes low (true).

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Adjust the Pulse Generator controls to obtain a square wave with a frequency less than the talk rate of the device under test and a minimum output. Connect the Generator OUTPUT between the ground lug and ATN test point on the Test Card. Set the Analyzer to LISTEN/FAST/COMP–OFF.

3. Connect the Oscilloscope vertical inputs to the ATN and DAV test points on the Test Card and adjust the Generator for a signal amplitude of 0 to + 5 volts at the ATN test point.

4. Trigger the Oscilloscope on the neagtive–going edge of the ATN signal and observe that the DAV signal goes high in less than 200 nanoseconds after ATN goes low.

5. Remove the Oscilloscope vertical input from the DAV test point and connect it to an active DIO test point. Observe that the DIO signal goes high in less than 200 nanoseconds after the ATN signal goes low.

6. Remove the Oscilloscope input from the DIO test point and connect it to the EOI test point. If the device is driving the EOI line low, the EOI signal must go high in less than 200 nanoseconds after ATN goes low.

7. Press and hold the Analyzer EXECUTE button and repeat the procedures in Steps 5 and 6.

NOTE

It may be necessary to use a counter to measure the time between signals if the talk rate of the device under test is too slow for the Oscilloscope to display.

TALKER AND EXTENDED TALKER INTERFACE FUNCTION

4-1. DESCRIPTION.

4-2. The Talker Interface Function provides a device with the capability to send device dependent data (including status data) over the interface to other devices. This capability exists only when the Talker Interface Function is addressed to talk. There are two alternative versions of the Function, one with and one without address extension. The normal Talker Interface Function uses a one-byte address. The Talker Interface Function with address extension (Extended Talker Function) uses a two-byte address.

4-3. Talker Interface Function Codes.

4-4. The basic code used to identify the Talker Interface Function is "T" while the basic code for the Extended Talker Interface Function is "TE". The codes used to identify the Talker or Extended Talker Interface Function capability of a particular device are T0 or TE0 which indicates the device has no Talker or Extended Talker Interface capability, and T1 through T8 or TE1 through TE8 which indicate various specified capabilities.

4-5. Talker Interface Function Requirements and Tests.

a. When power is first applied, the device under test must *not* "come on" addressed to "talk" or in the serial poll mode. *This test applies to devices classified T1 through T8 and TE1 through TE8.*

NOTE

Devices with "talk only" capability must not be in the talk only mode for this test.

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT and connect it to the HP–IB connector of the device under test. Connect the 59405-66503 Test Card to the Bus cable at the device under test.

2. Apply power to the device under test. The device must *not* drive the DAV, EOI, or any of the DIO lines low (true). The Analyzer DAV and EOI indicators must be unlit and the digital display must read "000".

b. The device under test must become addressed to "talk" when the IFC signal is high (false) and the "talk" only" message (ton) is true. *This test applies to devices classified T1, T3, T5, T7, TE1, TE3, TE5, or TE7 only.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT.

2. Set the device under test to the "talk only" mode. The device must apply data to the DIO lines and set the DAV line low (true).

3. Switch the "talk only" mode OFF and momentarily switch the Analyzer SRQ/IFC switch to IFC. The device under test must stop driving the DAV, EOI, and all DIO lines. The Analyzer DAV and EOI indicators must be unlit and the digital display must read "000".

c. The device under test must become addressed to "talk" only upon receiving its individual talk address code and must become unaddressed to talk upon receiving a talk address code other than its own or the Untalk Command (UNT). *This test applies to devices classified T1 through T8 or TE1 through TE8.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. If the device is an Extended Talker, set the lower switch register to the secondary talk address and again momentarily press the EXECUTE button.

2. Set the Analyzer to LISTEN/HALT. The device under test must drive DAV low (true) and output the first byte of data on the DIO lines.

3. Set the Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to a talk address other than that of the device being tested, set ATN to "1", and momentarily press the EXECUTE button.

4. Set the Analyzer to LISTEN/HALT. The device must have stopped driving all Bus lines (the Analyzer will drive the NDAC line) indicating it is no longer addressed to talk.

5. Repeat Steps 3 and 4 to check all talk addresses other than the talk address of the device being tested.

6. Readdress the device to talk as outlined in Steps 1 and 2. Set the Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the "untalk" command (octal code ATN 137) and momentarily press the EXECUTE button. Set the Analyzer to LISTEN/HALT. The device must have stopped driving all Bus lines (the Analyzer will drive NDAC) indicating it is no longer addressed to talk.

d. The device under test must become unaddressed to talk in less than 100 microseconds after receiving IFC low (true). *This test applies to devices classified T1 through T8 and TE1 through TE8.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. If the device is an Extended Talker, set the lower switch register to the secondary talk address and again momentarily press the EXECUTE button. Set the Analyzer to LISTEN/HALT and verify that the device is addressed to talk. (The device must drive DAV low and output the first byte of data on the DIO lines.)

2. Adjust the Pulse Generator controls to obtain a square wave with a negative pulse width of 100 microseconds (5 kHz) and an amplitude of 0 to + 5 volts.

3. Connect the Generator OUTPUT between the GND and IFC test point on the Test Card. The device under test must stop driving all Bus lines. (The IFC line will be driven by the Pulse Generator.)

e. The device under test must enter the serial poll mode if IFC is high (false), the device is addressed to talk, and the Serial Poll Enable Command (SPE) is received. *This test applies to devices classified T1, T2, T5, T6, TE2, TE5, or TE6.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. If the device is an Extended

Talker, set the lower switch register to the secondary talk address and again momentarily press the EXECUTE button.

2. Set the Analyzer to LISTEN/HALT. The device under test must drive DAV low (true) and output the first byte of data on the DIO lines.

3. Set the Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the SPE command (octal code ATN 030) and momentarily press the EXECUTE button.

4. Set the Analyzer to LISTEN/HALT. The device must output a status byte. The status byte, in octal code, will be of the form "1XX" to indicate the device requested service, or "0XX" to indicate the device did not request service. (Digits indicated by "X" are device dependent.)

5. Set the Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the Serial Poll Disable (SPD) command (octal code ATN 031) and momentarily press the EXECUTE button. The device under test must stop responding to the serial poll.

6. Set the Analyzer lower switch register to the SPE command (octal code ATN 030) and momentarily press the EXECUTE button.

7. Set the lower switch register to the talk address of the device under test (with ATN set to "1") and momentarily press the EXECUTE button.

8. Set the Analyzer to LISTEN/HALT. The device under test must respond to the serial poll by outputting its status byte.

f. The device under test must exit the serial poll mode within 100 microseconds after receiving IFC low (true). *This test applies to devices classified T1, T2, T5, T6, TE1, TE2, TE5, or TE6.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. If the device is an Extended Talker, set the lower switch register to the secondary talk address and again momentarily press the EXECUTE button.

2. Set the lower switch register to the SPE command (octal code ATN 030) and momentarily press the EXECUTE button. Set the Analyzer to LISTEN/HALT. The device should now be in the serial poll mode.

3. Adjust the Pulse Generator controls to obtain a square wave with a negative pulse width of 100 microseconds (5 kHz) and an amplitude of 0 to + 5 volts.

4. Connect the Generator OUTPUT between the GND and IFC test points on the Test Card. The device being tested must stop driving all Bus lines. (The IFC line will be driven by the Pulse Generator.)

5. Readdress the device to talk as in Step 1. Set the Analyzer to LISTEN/HALT. The device should again respond to the serial poll and output a status byte on the DIO lines.

g. The device under test must exit the serial poll mode upon receiving the Serial Poll Disable command (SPD). *This test applies to devices classified T1, T2, T5, T6, TE1, TE2, TE5, or TE6.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. If the device is an Extended Talker, set the lower switch register to the secondary talk address and again momentarily press the EXECUTE button.

2. Set the lower switch register to the SPE command (octal code ATN 030) and momentarily press the EXECUTE button. Set the Analyzer to LISTEN/HALT and confirm that the device is in the serial poll mode.

3. Set the Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the SPD command (octal code ATN 031) and momentarily press the EXECUTE button.

4. Set the Analyzer to LISTEN/HALT. The device should drive the DAV line low (true) and output the first byte of device dependent data on the DIO lines.

5. Momentarily switch the Analyzer SRQ/IFC switch to IFC.

6. Set the Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the SPE command (octal code ATN 030) and momentarily press the EXECUTE button.

7. Set the Analyzer lower switch register to the SPD command (octal code ATN 031) and momentarily press the EXECUTE button.

8. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

9. Set the Analyzer to LISTEN/HALT. The device should drive the DAV line low (true) and output the first byte of device dependent data.

h. The device under test must become unaddressed to talk and addressed to listen upon receiving its listen address. *This test applies to devices classified T5, T6, T7, T8, TE5, TE6, TE7, or TE8.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. If the device is an Extended Talker, set the lower switch register to the secondary talk address and again momentarily press the EXECUTE button.

2. Set the Analyzer to LISTEN/HALT. The device under test must drive DAV low (true) and output the first byte of data on the DIO lines.

3. Switch the Analyzer back to TALK/HALT/MEMORY–OFF. Set the lower switch register to the "listen" address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button. If the device is an Extended Listener, set the lower switch register to the secondary listen address and again momentarily press the EXECUTE button.

4. Set all switches in the lower switch register to "0". The device under test must drive the NDAC line low (true).

i. If the device under test is capable of driving EOI, it must do so when sending the last byte of device dependent data. This test applies to devices classified T1 through T8 and TE1 through TE8.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Set the Analyzer to LISTEN/HALT. Accept characters from the device under test one at a time by momentarily pressing the Analyzer EXECUTE button. The device under test must drive EOI low (true) at the same time it outputs the last byte of data.

REMOTE LOCAL INTERFACE FUNCTION

5-1. DESCRIPTION.

5-2. The Remote Local Interface Function provides a device with the capability to select between two sources of input information. The Remote Local Interface Function indicates to the device that either input from the front panel controls (local) or corresponding input information from the Bus is to be used.

5-3. Remote Local Interface Function Codes.

5-4. The basic code used to identify the Remote Local Interface Function is "RL". The codes used to denote the Remote Local Interface Function capability of a particular device are RL0, which indicates the device has no Remote Local Interface capability, and RL1 and RL2, which denote particular specified capabilities.

5-5. Remote Local Interface Function Requirements and Tests.

a. When power is first applied, the device under test must "come on" in the local mode. *This test applies to devices classified RL1 or RL2.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT and connect it to the HP–IB connector of the device to be tested. Connect the 59405-66503 Test Card to the Bus cable at the device under test.

2. Apply power to the device under test. The device must respond to its front panel controls and not respond to data transmitted on the Bus.

3. Switch the Analyzer REN switch to REN. The device under test must remain in local and not respond to Bus data.

b. The device under test must enter the remote mode if REN is low (true) and the device receives its listen address. *This test applies to devices classified RL1 or RL2.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and switch the REN switch to REN. Set the lower switch register to the listen address of the

device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

NOTE

If the device is an Extended Listener, it will be necessary to send both a primary and secondary listen address.

2. The device should now be in the remote mode and must not respond to its front panel controls.

c. The device under test must exit the remote mode in less than 100 microseconds after the REN signal goes high. *This test applies to devices classified RL1 or RL2.*

TEST:

1. Adjust the Pulse Generator controls to obtain a 100 microsecond pulse with an amplitude of 0 to + 5 volts.

2. Set the Generator repetition rate to MANUAL and connect the OUTPUT between the GND and REN test points on the Test Card.

3. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF/REN–OFF. Set the lower switch register to the listen address of the device under test and momentarily press the EXECUTE button.

4. Make certain the device is in the remote mode by testing its front panel controls. The device should not respond to the front panel controls.

5. Momentarily press the Pulse Generator's MANUAL trigger button. (The Generator should output a single 100 microsecond pulse.) The device under test must return to the local mode and respond to its front panel controls.

6. Remove the Pulse Generator OUTPUT from the Test Card.

d. If the device under test is addressed to listen, it must go to the local mode upon receiving the Go To Local Command (GTL). *This test applies to devices classified RL1 or RL2.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and switch the REN switch to REN. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Make certain the device is in the remote mode.

3. Set the Analyzer lower switch register to the Go To Local command (octal code ATN 001) and momentarily press the EXECUTE button. The device must respond to its front panel controls, indicating it is in the local mode.

e. The device under test must switch from remote to local control when the front panel "return to local" switch is pressed if the device has not received the Local Lockout Command (LLO). If the return to local message is true the device must still remain addressed to listen. *This test applies to devices classified RL1 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and switch the REN switch to REN. Set the lower switch register to the listen address of the

device under test, set ATN to "1", and momentarily press the EXECUTE button.

2. The device under test should not respond to its front panel controls, indicating it is in the remote mode.

3. Press the "return to local" switch of the device being tested. The device must now respond to its front panel controls.

4. Switch the Analyzer ATN switch to the "0" position. The NDAC indicator must remain lit, indicating the device is still addressed to listen. Return the ATN switch to the "1" position.

5. Momentarily press the Analyzer EXECUTE button. The device must return to the remote mode.

f. The device under test must ignore the "return to local" command (rtl) after receiving the "local lockout" command (LLO) while the remote enable message (REN) is true. *This test applies to devices classified RL1 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and switch the REN switch to REN. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXE–CUTE button.

2. Set the Analyzer lower switch register to the Local Lockout Command (octal code ATN 021) and momentarily press the EXECUTE button.

3. Press the "return to local" switch of the device under test. The device must remain in the remote mode and not respond to the front panel controls.

4. Switch the Analyzer REN switch OFF and then back to REN. The device must remain addressed to listen and return to local control. Set the ATN switch to "0". The NDAC indicator must remain lit, indicating the device is still addressed to listen.

5. Readdress the device to listen, as in Step 1. The device must go to the remote mode. Press the return to local switch of the device being tested. The device must return to the local mode.

DEVICE CLEAR INTERFACE FUNCTION

6-1. DESCRIPTION.

6-2. The Device Clear Interface Function provides the device with the capability to be cleared (initialized) either individually or collectively as part of a group. The group may be a subset or all addressed devices in one system.

6-3. Device Clear Interface Function Codes.

6-4. The basic code used to identify the Device Clear Interface Function is "DC". The codes used identify the Device Clear Interface Function capability of a particular device are DC0, which indicates the device has no Device Clear Interface Function capability, and DC1 and DC2, which specify particular capabilities.

6-5. Device Clear Interface Function Requirements and Tests.

a. The device under test must go to a predefined state upon receiving the "device clear" command (DCL) if ATN is true and the device has been addressed to listen. *This test applies to devices classified DC1 or DC2.*

NOTE

If the device is classified DC2 and does not have "listen" capability, replace Steps 1 and 2 with the following procedure:

Set the front panel controls of the device under test to a non-cleared mode of operation.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and switch the REN to REN. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Program the device under test to a "non-cleared" mode by setting the Analyzer lower switch register to the required character and pressing the EXECUTE button. (It may be necessary to output more than one character.)

3. Set the Analyzer lower switch register to the DCL command (octal code ATN 024) and momentarily press the EXECUTE button. The device must go to the "cleared" mode.

b. The device under test must go to a predefined state upon receiving the Selected Device Clear Command (SDC) if the device has been addressed to listen and the ATN signal is true. *This test applies to devices classified DC1 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and switch the REN switch to REN. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXE–CUTE button.

2. Program the device under test to a "non-cleared" mode by setting the Analyzer lower switch register to the required character and pressing the EXECUTE button. (It may be necessary to output more than one character.)

3. Set the Analyzer lower switch register to the SDC command (octal code ATN 004) and momentarily press the EXECUTE button. The device must go to the "cleared" mode.

c. The device under test must respond to the Device Clear Command (DCL) but *not* respond to the Selected Device Clear Command (SDC) when unaddressed to listen. *This test applies to devices classified DC1 only.*

TEST:

1. Program the device under test as described in Steps 1 and 2 of Part B.

2. Set the Analyzer lower switch register to the unlisten command (octal code ATN 077) and momentarily press the EXECUTE button.

3. Set the lower switch register to the DCL command (octal code ATN 024) and momentarily press the EXECUTE button. The device must go to the "cleared" mode.

4. Program the device under test as described in Steps 1 and 2 of Part B.

5. Set the Analyzer lower switch register to the unlisten command (octal code ATN 077) and momentarily press the EXECUTE button.

6. Set the lower switch register to the SDC command (octal code ATN 004) and momentarily press the EXECUTE button. The device under test must *not* go to the "cleared" mode.

DEVICE TRIGGER INTERFACE FUNCTION

7-1. DESCRIPTION.

7-2. The Device Trigger Interface Function provides the device with the capability to have its basic (measurement) operation initiated either individually or collectively as part of a group of devices. The group may be either a subset or all addressed devices in one system.

7-3. Device Trigger Interface Function Codes.

7-4. The basic code used to identify the Device Trigger Interface Function is "DT". The codes used to denote the Device Clear Interface Function capability of a particular device are DT0, which indicates the device has no Device Trigger Interface capability, and DT1, which indicates the device has complete Device Trigger Interface capability.

7-5. Device Trigger Interface Function Requirements and Tests.

a. The measurement sequence, of the device under test, must be initiated upon receiving the Group Execute Trigger command (GET) if the device is addressed to listen.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Set the lower switch register to the GET command (octal code ATN 010) and momentarily press the EXECUTE button. The device under test must initiate the measurement sequence when the EXECUTE button is pressed.

3. Set the lower switch register to the Unlisten command (octal code ATN 077) and momentarily press the EXECUTE button.

4. Reset the Analyzer lower switch register to the GET command (octal code ATN 010) and momentarily press the EXECUTE button. The device under test must *not* respond to the GET command.

SERVICE REQUEST INTERFACE FUNCTION

8-1. DESCRIPTION.

8-2. The Service Request Interface Function provides a device with the capability to asynchronously request service from the controller in charge of the Interface. This function also synchronizes the value of the service request bit of the status byte present during a serial poll so that the Service Request message (SRQ) can be removed from the Interface once this bit has been received true by the controller in charge.

8-3. Service Request Interface Function Codes.

8-4. The basic code used to identify the Service Request Interface Function is "SR". The codes used to denote the Service Request Interface Function capability of a particular device are SR0, which indicates the device has no Service Request Interface capability; and SR1 which indicates the device has complete Service Request Interface capability.

8-5. Service Request Interface Function Requirements and Tests.

a. The device under test must *not* drive the SRQ line low (true) when power is initially applied.

TEST:

1. Set the Bus System Analyzer to the TALK/HALT/MEMORY–OFF mode and connect it to the HP–IB connector of the device being tested.

2. Set all lower switches of the Analyzer to the "0" position and apply power to the device under test. The device must not drive the SRQ line low as indicated by the Analyzer SRQ indicator being unlit.

b. If the device under test is not actively responding to a serial poll and does not require service, it must not drive the SRQ line low (true).

TEST:

1. Observe that the Analyzer SRQ indicator is not lit.

c. If the device under test does not require service it must indicate this by driving the DIO7 line high (false) when it is actively responding to a serial poll.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the Serial Poll Enable command (octal code ATN 030) and momentarily press the EXECUTE button.

2. Set the lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

3. Switch the Analyzer to LISTEN/HALT. The device should now be actively responding to the serial poll. The Analyzer digital readout should display octal code "0XX" or "2XX". (The "X" indicates the digit displayed is dependent upon the device being tested.)

d. If the device under test is not actively responding to a serial poll and requires service, it must drive the SRQ line low (true).

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the Serial Poll Disable command (octal code ATN 031) and momentarily press the EXECUTE button.

2. Cause the device under test to request service (drive the SRQ line low). The Analyzer SRQ indicator must light.

NOTE

There is no particular method of causing a device to request service. Refer to the Operating and Service Manual of the device being tested to determine a means of causing the device to request service.

3. Set the lower switch register to the Serial Poll Enable command (octal code ATN 030) and momentarily press the EXECUTE button. Reset the lower switch register to the talk address of the device under test and again momentarily press the EXECUTE button. The device should now be addressed to talk in the serial poll mode. The Analyzer SRQ indicator must remain lit.

4. Switch the Analyzer to LISTEN/HALT. The device under test must stop driving the SRQ line low (SRQ indicator unlit), and drive the DIO7 line low (true) indicating it did request service. The Analyzer digital readout should display octal code "1XX" or "3XX". (The "X" indicates the digit displayed is dependent upon the device being tested.) Press the EXECUTE button to accept one byte of information.

e. The device under test must continue driving the SRQ line low (true) after receiving the IFC message if it requires service.

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the Serial Poll Disable command (octal code ATN 031) and momentarily press the EXECUTE button.

2. Cause the device to request service (drive the SRQ line low). The Analyzer SRQ indicator must light.

3. Momentarily switch the Analyzer SRQ/IFC switch to IFC. The device under test must continue driving the SRQ line low (true). The Analyzer SRQ indicator must remain lit.

PARALLEL POLL INTERFACE FUNCTION

9-1. DESCRIPTION.

9-2. The Parallel Poll Interface Function provides a device with the capability to output one bit of status information to the controller in charge without being previously addressed to talk.

9-3. The signal lines, DIO1 through DIO8, are used to convey the device status bits during the Parallel Poll. This allows the status of up to eight devices to be checked simultaneously. Any number of devices can be checked by sharing of the DIO lines.

9-4. The use of the Parallel Poll facility within a system requires that the controller must periodically conduct a Parallel Poll.

9-5. The Parallel Poll differs from the Serial Poll in that a device can request service only when polled, in a Parallel Poll configuration. Each device is assigned an individual DIO line on which to respond to the Parallel Poll, allowing the controller to identify the device or devices requiring service immediately.

9-6. Parallel Poll Interface Function Codes.

9-7. The basic code used to identify the Parallel Poll Interface Function is "PP". The codes used to denote the Parallel Poll Interface Function capability of a particular device are PP0, which indicates the device has no Parallel Poll Interface capability, and PP1 or PP2 which specify particular Parallel Poll Interface capabilities.

9-8. Parallel Poll Interface Function Requirements and Tests.

a. The device under test must *not* "come on" in the Parallel Poll mode when power is first applied. *This test applies to devices classified PP1 or PP2.*

NOTE

Devices classified PP2 must **not** *be in the "local poll enable" (lpe) mode for this test.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and connect it to the HP–IB connector of the device under test. Set all switches in the lower switch register to "0".

2. Apply power to the device under test. The device must not drive any of the DIO lines low (true). The Analyzer readout must display octal code "000".

3. Set the Analyzer EOI and ATN switches to the "1" position. The device under test must not drive any of the DIO lines low (true). The digital readout must display "000".

b. The device under test, after being addressed to listen and having received both the Parallel Poll Configure command (PPC) and the Parallel Poll Enable command (PPE), must respond to a Parallel Poll on the DIO line assigned and in the "sense" indicated by the Parallel Poll Enable code when it receives both ATN and EOI low (true). The device must "stand by" for Parallel Poll after receiving the Parallel Poll Enable command and before EOI is set low. *This test applies to devices classified PP1 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the listen address code of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Set the Analyzer lower switch register to the PPC command (octal code ATN 005) and momentarily press the EXECUTE button. The device under test should now be configured for Parallel Poll.

3. Reset the lower switch register to the Parallel Poll Enable command (octal code ATN 150) and momentarily press the EXECUTE button. The device should now be in standby for parallel poll.

NOTE

The Parallel Poll Enable code is an eight digit binary code in the form X, 1, 1, 0, S, P3, P2, P1 where "X" can take on the value of either "0" or "1", "S" determines the "sense" of the poll, and P3, P2, and P1 program which DIO line the device will respond on when active. Octal code 150 converted to binary would be X, 1, 1, 0, 1, 0, 0, 0. The "sense of the poll is "1" and the device would be programmed to respond to the poll on the DIO1 line.

4. Set all switches in the lower switch register to "0". Switch the ATN and EOI switches to the "1" position. If the device requires service the Analyzer digital display should read "001". If the device does not require service the display should read "000", before and after the EOI switch is switched from the "0" position to the "1" position.

5. Return the EOI switch to the "0" position. The Analyzer digital display should read "000".

6. Set the Analyzer lower switch register to the Parallel Poll Enable command (octal code ATN 140) and momentarily press the EXECUTE button.

7. Set all DIO switches to the "0" position. Set the ATN and EOI switches to "1". If the device requires service, the digital display should read "000". If the device does not require service the display should read "001". Set the EOI switch to "0". The display must read "000".

8. Repeat Steps 3 through 7 for the Parallel Enable Codes and responses listed in Table 9-1.

Table 9-1. Bus Conditions for Parallel Poll.

PARALLEL POLL ENABLE CODES		PARALLEL POLL ACTIVE RESPONSE (octal code)		DEVICE RESPONDS ON LINE
"1" Sense	"0" Sense	Service Requested	Service Not Requested	
150		001	000	DIO1
	140	000	001	DIO1
151		002	000	DIO2
	141	000	002	DIO2
152		004	000	DIO3
	142	000	004	DIO3
153		010	000	DIO4
	143	000	010	DIO4
154		020	000	DIO5
	144	000	020	DIO5
155		040	000	DIO6
	145	000	040	DIO6
156		100	000	DIO7
	146	000	100	DIO7
157		200	000	DIO8
	147	000	200	DIO8

c. The device under test must respond to a Parallel Poll in less than 200 nanoseconds after receiving ATN and EOI low (true). The device must stop responding within 200 nanoseconds after ATN or EOI go high (false). *This test applies to devices classified PP1 only.*

TEST:

1. Connect the 59405-66503 Test Card to the Bus cable at the device under test.

2. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the listen address of the device under test and momentarily press the EXECUTE button.

3. Set the lower switch register to the Parallel Poll Configure command (octal code ATN 005) and momentarily press the EXECUTE button.

4. Set the lower switch register to the Parallel Poll Configure command (octal code ATN 005) and momentarily press the EXECUTE button.

5. Set the lower switch register to the Unlisten command (octal code ATN 077) and momentarily press the EXECUTE button.

6. Clear the Analyzer memory and load the following program into memory:

Table 9-2. Parallel Poll Test Pattern.

Memory Location Number	Memory Contents (octal code)
00	EOI ATN 000
01	000
02	EOI ATN 000
03	000
28	EOI ATN 000
29	000
30	EOI ATN 000
31	000

7. Switch the Analyzer memory OFF and set the Analyzer to TALK/FAST.

8. Connect the Oscilloscope vertical inputs to the EOI and DIO1 test points on the Test Card. Trigger the Oscilloscope on the negative-going edge of the EOI signal. The DIO1 signal must go low (true) in less than 200 nanoseconds after the EOI signal goes low (true).

9. Trigger the Oscilloscope on the positive-going edge of the EOI signal. The DIO1 signal must go high (false) in less than 200 nanoseconds after the EOI signal goes high (false).

d. The device under test must *not* "stand by" for Parallel Poll after receiving the Parallel Poll Unconfigure command (PPU) or the Parallel Poll Disable command (PPD) if it has previously configured for parallel poll. *This test applies to devices classified PP1 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Set the lower switch register to the Parallel Poll Configure command (octal code ATN 005) and momentarily press the EXECUTE button.

3. Set the lower switch register to the Parallel Poll Enable command (octal code ATN 140 if the device does not require service, octal code ATN 150 if the device requires service) and momentarily press the EXECUTE button.

4. Insure that the device will respond to the Parallel Poll by setting all DIO switches to "0" and setting the ATN and EOI switches to "1". The Analyzer digital display should read "001". Return the EOI switch to the "0" position.

5. Set the Analyzer lower switch register to the Parallel Poll Unconfigure command (octal code ATN 025) and momentarily press the EXECUTE button.

6. Set all Analyzer DIO switches to the "0" position and set the ATN and EOI switches to the "0" position and set the ATN and EOI switches to "1". The device must not respond to the Parallel Poll. The Analyzer digital display must read "000".

7. Repeat Steps 1 through 4 to put the device in the Parallel Poll mode.

8. Set the Analyzer lower switch register to the Parallel Poll Disable command (octal code ATN 160) and momentarily press the EXECUTE button.

9. Set all Analyzer DIO switches to the "0" position and set the ATN and EOI switches to "1". The device should not respond to the Parallel Poll. The Analyzer digital display must read "000".

e. The device under test must remain in "standby" for Parallel Poll when it receives the Parallel Poll Disable command (PPD) if it is not addressed to listen. *This test applies to devices classified PP1 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set the lower switch register to the listen address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

2. Set the lower switch register to the Parallel Poll Configure command (octal code ATN 005) and momentarily press the EXECUTE button.

3. Set the lower switch register to the Parallel Poll Enable command (octal code ATN 140 if the device does not require service, octal code ATN 150 if the device requires service) and momentarily press the EXECUTE button.

4. Insure that the device will respond to the Parallel Poll by setting all DIO switches to "0" and setting the ATN and EOI switches to "1". The Analyzer digital display should read "001". Return the EOI switch to "0".

5. Set the Analyzer lower switch register to the Unlisten command (octal code ATN 077) and momentarily press the EXECUTE button.

6. Set the lower switch register to the PPD command (octal code ATN 160) and momentarily press the EXECUTE button.

7. Set all DIO switches to "0" and switch the ATN and EOI switches to "1". The device must again respond to the Parallel Poll. The Analyzer digital display must read "001".

8. Set the lower switch register to the Parallel Poll Unconfigure command (octal code ATN 025) and momentarily press the EXECUTE button. The device must not respond to the Parallel Poll when ATN and EOI are true.

f. The device under test must *not* "stand by" for Parallel Poll when the Local Poll Enable message (lpe) is false. *This test applies to devices classified PP2 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and connect it to the HP–IB connector of the device under test. Set all switches in the lower switch register to the "0" position.

2. Set the Local Poll Enable of the device under test to OFF and the "sense" to "1".

3. Set the Analyzer ATN and EOI switches to the "1" position. The device must *not* drive any of the DIO lines low (true). The Analyzer digital display must read "000".

4. Change the "sense" bit of the device under test to "0". The device must *not* drive any of the DIO lines low (true). The Analyzer digital display must read "000".

g. The device under test must "stand by" for Parallel Poll when the Local Poll Enable message (lpe) is true. *This test applies to devices classified PP2 only.*

TEST:

1. Set the Analyzer to TALK/HALT/MEMORY–OFF. Set all switches in the lower switch register to the "0" position.

2. Set the Local Poll Enable of the device under test to ON and the "sense" switch to "1". The device should now be in "standby" for Parallel Poll. Set the device to respond on the DIO1 line.

3. Set the Analyzer ATN and EOI switches to "1". If the device requires service it must drive the DIO1 line low. The Analyzer digital readout should read "001". If the device does not require service, set the "sense" switch of the device to "0". The Analyzer digital display should read "001".

4. Repeat Steps 2 and 3 to test DIO lines 2 through 8.

h. The device under test must respond to a Parallel Poll in less than 200 nanoseconds after both the ATN and EOI signals go low (true) if the Local Poll Enable message (lpe) is true. The device must stop responding in less than 200 nanoseconds after either the ATN or EOI signal goes high (false). *This test applies to devices classified PP2 only.*

TEST:

1. Set the Local Poll Enable switch of the device under test to ON. Set the device to respond on the DIO1 line and set the "sense" switch to "0" or "1" so the device will drive the DIO1 line low (true) when it responds.

2. Set the Bus System Analyzer to TALK/HALT/MEMORY–ON and load the following program into memory:

Table 9-3. Parallel Poll Test Pattern.

Memory Location Number	Memory Contents (octal code)
00	EOI ATN 000
01	000
02	EOI ATN 000
03	000
28	EOI ATN 000
29	000
30	EOI ATN 000
31	000

3. Switch the memory OFF and set the Analyzer to TALK/FAST.

4. Connect the Oscilloscope vertical inputs to the EOI and DIO1 test points on the Analyzer rear panel. Trigger the Oscilloscope on the negative–going edge of the EOI signal. The DIO1 signal must go low (true) in less than 200 nanoseconds after EOI goes low (true).

NOTE

If the DIO1 line is not being driven low, change the "sense" switch of the device under test.

5. Trigger the Oscilloscope on the positive–going edge of the EOI signal. The DIO1 signal must go high (false) in less than 200 nanoseconds after EOI goes high (false).

CONTROLLER INTERFACE FUNCTION

10-1. DESCRIPTION.

10-2. The Controller Interface Function provides a device with the capability to send device addresses, universal commands, and addressed commands to other devices over the Interface. It also provides the capability to conduct parallel polls to determine which devices require service. A Controller Interface Function can exercise its capabilities only when it is sending the ATN message over the Interface. Only one device can be an active controller at any given time even though more than one device on the Interface has the Controller Interface Function capability. Only one controller on the Interface is allowed to send the IFC and REN messages and take control of the Interface at any time. This device is called the System Controller.

10-3. Controller Interface Function Codes.

10-4. The basic code used to identify the Controller Interface Function is "C". The codes used to identify the Controller Interface Function capability of a particular device are "C0" which indicates the device has no Controller Interface capability; and "C1" through "C28" which specify various Controller Interface capabilities.

10-5. Controller Interface Function Requirements and Tests.

a. The device under test must become a System Controller and send the IFC message if the local Request System Control message (rsv) and the local Send Interface Clear message (sic) are true. The device must set IFC low (true) for more than 100 microseconds, and until the "sic" message is false. *This test applies to devices classified as both C1 and C2 only. (C1 capability is required for devices having C2 capability.)*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Connect the Oscilloscope vertical input to the Test Card IFC test point.

2. Activate the device as a System Controller and send the Interface Clear message. The device must drive IFC low for more than 100 microseconds.

3. Remove the Oscilloscope input and connect the Counter to the IFC test point. Send several IFC messages. The device must not send an IFC signal with a pulse width less than 100 microseconds.

4. The device must not send the IFC message if either the "rsv" or "sic" message is false.

b. The device under test must become a System Controller and send the Remote Enable message (REN) if the "rsv" message and the Send Remote Enable message (sre) are true. The device must not send REN true unless the "sre" message has been true for more than 100 microseconds. The device must hold REN true until the "sre" message becomes false. *This test applies to devices classified as both C1 and C3 only. (C1 capability is required for devices having C3 capability.)*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF/REN–OFF. Connect the Oscilloscope vertical input to the Test Card REN test point. The REN signal must be high (false).

2. Activate the device as a system controller (rsv true) and send the Remote Enable message (REN). The REN line must be driven low (true).

3. Program the device to send REN true and then false at its maximum rate. The positive portion of the REN signal must be greater than 100 microseconds in duration.

NOTE

Devices classified as having C1, C2, and C3 Interface capability must be capable of performing the IFC and REN functions independently.

c. The device under test must respond to the Service Request message (SRQ). *This test applies to devices classified C4 only.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT and momentarily switch the SRQ/IFC switch to IFC.

2. Activate the device under test as a controller.

3. Switch the Analyzer SRQ/IFC switch to SRQ. The device under test must respond to the Service Request message.

NOTE

The response to the Service Request message is dependent upon the particular device being tested. Refer to the Operating and Service Manual of the device being tested for its particular response to SRQ.

The device under test may have any or all of the preceding capabilities (C1 through C4) but may have only one of the following capabilities (C5 through C28).

d. The device under test must stop driving the ATN, EOI, and DIO lines low (true) within 100 microseconds after receiving the Interface Clear message (IFC) low if the device is *not* an active System Controller. *This test applies to devices classified C5 through C28.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and set all switches in the lower switch register to the "0" position.

2. Adjust the Pulse Generator controls to obtain a square wave with a negative pulse width of 100 microseconds (5 kHz) and an amplitude of 0 to + 5 volts. Set the repetition rate to MANUAL and connect the Generator OUTPUT between the GND and IFC test points on the Analyzer rear panel.

3. Program the device under test to continuously send commands on the Bus. (Drive the ATN and DIO lines.)

4. Momentarily press the Generator MANUAL trigger button. The device under test must stop driving the ATN and EOI line low. The Analyzer ATN and EOI indicator must be unlit. The device under test must stop driving the ATN and DIO lines. The Analyzer ATN indicator must be unlit and the digital display must read "000".

5. Program the device to drive the ATN and EOI lines. Momentarily press the Generator MANUAL trigger button. The device under test must stop driving the ATN and EOI lines low. The Analyzer ATN and EOI indicators must be unlit.

e. The device under test must become the "Controller in Charge" when the ATN signal goes high (false) if the IFC message is false, if the device has been addressed to talk, and if it has received the "take control" command (TCT). The device under test must become the Controller in Charge when the IFC signal goes high (false) if the device is the "active" System Controller and is driving the IFC line low (true). *This test applies to devices classified C5, C7, C9, C11, C13, C15, C17, C19, C21, C23, C25, or C27 only.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF and momentarily switch the SRQ/IFC switch to IFC to stop all Bus traffic. (If the device is an active system controller, it must be set to stop transmitting on the Bus ["rsc" set false]).

2. Set the Analyzer lower switch register to the talk address of the device under test, set the ATN switch to "1", and momentarily press the EXECUTE button.

3. Reset the lower switch register to the TCT command (octal code ATN 011) and momentarily press the EXECUTE button.

4. Set the Analyzer to LISTEN/HALT. The device under test must now have control of the Bus and be capable of driving the ATN and DIO lines.

NOTE

The following test applies to "System Controllers" only.

5. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF. Set all switches in the lower switch register to the "0" position.

6. Activate the device under test as a system controller (set "rsc" true) and cause it to drive the IFC line low (true). The device must not drive the ATN, EOI, or DIO lines low while IFC is true.

7. Cause the device to stop driving the IFC line low. The device must take control of the Bus and be capable of driving the ATN, EOI, and DIO lines.

NOTE

Only devices with Parallel Poll capability are required to drive the EOI line.

f. The device under test must *not* drive the DAV, ATN, EOI, or DIO lines after it has "passed control" to another device on the Bus. *This test applies to devices classified C5 through C12 and C17 through C24 only.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT/MEMORY–OFF and set all switches in the lower switch register to the "0" position.

2. Program the device under test to transmit a talk address, other than its own, on the Bus. Press the Analyzer EXECUTE button to accept the Bus information.

3. Program the device to send the TCT command (octal code ATN 011).

4. Press and hold the Analyzer EXECUTE button to accept the TCT command. The device must stop driving the ATN, DAV, EOI, and DIO lines. The Analyzer ATN, DAV, and EOI indicators must be unlit and digital display must read "000". Release the EXECUTE button.

g. The device under test must not lose control of the Bus when passing control to itself. *This test applies to devices classified C5 through C8 and C17 through C20 only.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT/MEMORY–OFF.

2. Program the device under test to send its own talk address on the Bus.

3. Momentarily press the Analyzer EXECUTE button to accept the character.

4. Program the device to send the TCT command (octal code ATN 011) on the Bus. The Analyzer ATN indicator must be lit.

5. Press and hold the EXECUTE button to accept the TCT command. The ATN indicator must remain lit, indicating the device still has control of the Bus. Release the EXECUTE button.

h. The device under test must be capable of sending device addresses, addressed commands, secondary commands, and universal commands. *This test applies to devices classified C5 through C28.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT/MEMORY–OFF.

2. Program the device under test to transmit the address codes listed in Table 10-1 on the Bus.

3. Accept each byte from the Bus by pressing the Analyzer EXECUTE button. The device must put the next byte of information on the Bus and set DAV low when the EXECUTE button is released. The Analyzer digital readout must display the octal code and ASCII character listed in Table 10-1 and the ATN indicator must be lit.

Table 10-1. Listen Address Codes.

Octal Code	ASCII Character	Octal Code	ASCII Character	Octal Code	ASCII Character
ATN 040	SP	ATN 053	+	ATN 066	6
ATN 041	!	ATN 054	'	ATN 067	7
ATN 042	"	ATN 055	–	ATN 070	8
ATN 043	≠	ATN 056	.	ATN 071	9
ATN 044	S	ATN 057	/	ATN 072	:
ATN 045	%	ATN 060	0	ATN 073	;
ATN 046	&	ATN 061	1	ATN 074	<
ATN 047	'	ATN 062	2	ATN 075	=
ATN 050	(	ATN 063	3	ATN 076	>
ATN 051	)	ATN 064	4		
ATN 052	*	ATN 065	5		

4. Program the device under test to transmit the talk address codes listed in Table 10-2. (Exclude the talk address of the device under test.)

Table 10-2. Talk Address Codes.

Octal Code	ASCII Character	Octal Code	ASCII Character	Octal Code	ASCII Character
ATN 100	@	ATN 113	K	ATN 126	V
ATN 101	A	ATN 114	L	ATN 127	W
ATN 102	B	ATN 115	M	ATN 130	X
ATN 103	C	ATN 116	N	ATN 131	Y
ATN 104	D	ATN 117	O	ATN 132	Z
ATN 105	E	ATN 120	P	ATN 133	[
ATN 106	F	ATN 121	Q	ATN 134	\
ATN 107	G	ATN 122	R	ATN 135	]
ATN 110	H	ATN 123	S	ATN 136	^
ATN 111	I	ATN 124	T		
ATN 112	J	ATN 125	U		

5. Accept each byte from the Bus by pressing the Analyzer EXECUTE button. The device must put the next byte of information on the Bus and set DAV low when the EXECUTE button is released. The Analyzer must display the octal codes and ASCII characters as listed in Table 10-2.

6. Program the device under test to transmit the "command codes listed in Table 10-3.

Table 10-3. Command Codes.

ADDRESSED COMMANDS			UNIVERSAL COMMANDS		
Command	Octal Code	ASCII Character	Command	Octal Code	ASCII Character
GTL go to local	ATN 001	SOH	LLO local lockout	ATN 021	DC1
SDC select device clear	ATN 004	EOT	DCL device clear	ATN 024	DC4
PPC parallel poll configure	ATN 005	ENQ	PPU parallel poll unconfigure	ATN 025	NAK
GET group execute trigger	ATN 010	BS	SPE serial poll enable	ATN 030	CAN
TCT take control	ATN 011	HT	SPD serial poll disable	ATN 031	EM

UNADDRESS COMMANDS		
Command	Octal Code	ASCII Character
UNL unlisten	ATN 077	?
UNT untalk	ATN 137	–

7. Accept each byte of information from the Bus by pressing the Analyzer EXE–CUTE button. The device must put the next byte of information on the Bus and set DAV low when the EXECUTE button is released. The Analyzer must display the octal codes as listed in Table 10-3.

i. If the device goes to "standby" (local "gts" message true) after transmitting address or command messages, it must set ATN high (false) after the last message has been sent. (Exclude the TCT command.) *This test applies to devices classified C5 through C24 only.*

TEST:

1. Set the Bus System Analyzer to LISTEN/FAST/MEMORY–OFF.

2. Program the device under test to transmit commands or addresses on the Bus. (Exclude the listen and talk addresses of the device and the TCT command.) The device under test must set ATN high and stop transmitting on the Bus after the last address or command is sent.

j. The device under test must set ATN low (true) when the "take control asynch-ronously" message (tca) is true. *This test applies to devices classified C5 through C28.*

TEST:

1. Set the Bus System Analyzer to TALK/HALT/MEMORY–OFF.

2. Program the device under test to take control of the Bus. The device must drive ATN low (true) when it has control. The Analyzer ATN indicator must light.

k. The device under test must take control and set ATN low (true) only when the DAV, NDAC, and NRFD signals are low (true) and the "take control synchronously" message (tcs) is true. *This test applies to devices classified C5, C7, C9, C11, C13, C15, C17, C19, C21, C23, C25, and C27 only.*

TEST:

1. Set the Bus System Analyzer to LISTEN/HALT/MEMORY–OFF. Connect a clip lead between the NDAC and DAV test points on the Test Card.

2. Program the device under test to take control synchronously. The device must *not* drive ATN low.

3. Press the Analyzer EXECUTE button. The device must now drive the ATN line low. The Analyzer ATN indicator must light.

4. Remove the clip lead from the NDAC and DAV test points.

l. The device under test must wait 2 microseconds (1.1 microseconds if a tri-state driver is used on the EOI line) after regaining control, before it can drive the DIO lines (if the device is not requesting parallel poll). *This test applies to devices classified C5 through C28.*

TEST:

1. Set the Bus System Analyzer to LISTEN/FAST/MEMORY–OFF/COMP–OFF.

2. Program the device under test to repeatedly send commands or addresses on the Bus, go to "standby",and regain control.

3. Connect the Oscilloscope vertical inputs to the Analyzer ATN test point and an active DIO test point (one which goes low when the device regains control and outputs commands or addresses). The device must *not* drive the DIO line low for at least 2 microseconds (1.1 microseconds if a tri-state driver is used on the EOI line) after setting ATN low.

NOTE

Because of the repetition rate of the device under test, it may be necessary to use a counter to measure the time between the negative-going ATN and DIO signals.

m. If the device under test regains control of the Bus for the purpose of conducting a parallel poll, it must not drive EOI low (true) for more than 500 nanoseconds after setting ATN low (true). The device must hold EOI low for at least 2 microseconds. The device must *not* drive the DIO lines for more than 1.5 microseconds (600 nanoseconds if the EOI line is driven by a tri-state driver) after setting EOI high (false). *This test applies to devices classified C5, C6, C9, C10, C13, C14, C17, C18, C21, C22, C25, and C26 only.*

TEST:

1. Set the Bus System Analyzer to LISTEN/FAST/MEMORY–OFF/COMP–OFF.

2. Program the device under test to repeatedly send commands or addresses on the Bus, go to "standby", regain control of the Bus, and conduct a parallel poll.

3. Connect the Oscilloscope vertical inputs to the Analyzer ATN and EOI test points. EOI must not go low for more than 500 nanoseconds after ATN goes low and must remain low for at least 2 microseconds.

4. Remove the Oscilloscope input from the ATN test point and connect it to an active DIO test point. The DIO line must not go low for more than 1.5 microseconds (600 nanoseconds if the EOI line is driven by a tri-state driver) after EOI goes high.

NOTE

Because of the repetition rate of the device under test, it may be necessary to use a counter to measure the time between the negative-going ATN and DIO signals.

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Cable: ELECTA JEDDAH

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Modern Electronic Establishment
(Branch)
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Tel: 44678-44813
Telex: 670136
Cable: ELECTA AL-KHOBAR

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Edificio Juban
c/o Costa Brava, 13
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E-**Barcelona** 17
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E-**Sevilla** 5
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C/Ramon Gordillo 1
(Entlo.)
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CH-8952 **Schlieren-Zürich**
Tel: (01) 7305240
Telex: 53933 hpag ch
Cable: HPAG CH

Hewlett-Packard (Schweiz) AG
Château Bloc 19
CH-1219 **Le Lignon-Geneva**
Tel: (022) 96 03 22
Telex: 27333 hpag ch
Cable: HEWPACKAG Geneva

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General Electronic Inc.
Nuri Basha-Ahnaf Ebn Kays Street
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Damascus
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Telex: 11215 ITIKAL
Cable: ELECTROBOR DAMASCUS

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Sawah & Co.
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B.P. 2308
Damascus
Tel: 16 367-19 697-14 268
Telex: 11304 SATACO SY
Cable: SAWAH, DAMASCUS

Suleiman Hilal El Mlawi
P.O. Box 2528
Mamoun Bitar Street, 56-58
Damascus
Tel: 11 46 63
Telex: 11270
Cable: HILAL DAMASCUS

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Tunisie Electronique
31 Avenue de la Liberte
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Corema
1 ter. Av. de Carthage
Tunis
Tel: 253 821
Telex: 12319 CABAM TN

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Besikyas, **Istanbul**
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Cable: EMATRADE/Ankara

Yilmaz Ozyurek
Milli Mudafaa Cad 16/6
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Telex: 42576 OZEK TR
Cable: OZYUREK ANKARA

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Iskra Commerce, n.sol.o.
Zastopstvo Hewlett-Packard
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Cable: HEWPAK Vienna
Telex: 75923 hewpak a

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Cable: HEWPACKSA Athens

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2336 E. Magnolia St.
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2424 East Aragon Rd.
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Albany 12205
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650 Perinton Hill Office Park
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El Paso 79902
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Richardson 75080
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Virginia Beach 23455
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Bellevue 98004
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Spokane 99202
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Medical/Analytical Only
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Charleston 25304
Tel: (304) 925-0492

WISCONSIN
150 South Sunny Slope Road
Brookfield 53005
Tel: (414) 784-8800

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Atlanta, Georgia...North Hollywood, California...Rockville, Maryland...Rolling Meadows, Illinois. Their complete addresses are listed above.

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APPENDIX C

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N.J.
03296	Nylon Molding Corp.	Springfield, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox.	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon.	Clifton Heights, Penn.
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N.Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company.	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16554	Electroid Co.	Union, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N.J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park, Cleveland, Ohio	
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark.	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

00015-49
Revised: May, 1970

From: Handbook Supplements
H4-1 Dated January 1970

APPENDIX C

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N.J.
03296	Nylon Molding Corp.	Springfield, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox.	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon.	Clifton Heights, Penn.
09922	Burndy Corp	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N.Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company.	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16554	Electroid Co.	Union, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N.J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark.	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

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CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G. E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U. S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaronech, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

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Revised: May, 1970

From: Handbook Supplements
H4-1 Dated January 1970